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University of Kansas Science Bulletin - Vol. XXXVIII - Part I
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ERRATA

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vol. XXXVIII, pt. I. Dec. 20, 1956.

Page 3, line 9; p. 6, line 11; p. 12, line 3; p. 297, line 13; p. 306, line 40; p. 308, line 1; p. 309, line 1 for *brachypodus* read *brachypoda.*

page 441, line 10, insert "that" after "structures"

page 443, line 33, for *Petiloglossa* read *Ptiloglossa*

page 464, line 10, for *Anthopora* read *Anthophora*

page 474, line 2, for *(ieunomia)* read *(Dieunomia)*

page 488, line 6, for *Fimbriata* read *fimbriata*

page 468, line 26; p. 469, line 6; p. 470, lines 7, 8, 9, 20; p. 490, lines 4, 5, 6, for *mellifica* read *mellifera.*

page 582, line 27, for 582, read 634.

page 589, line 27, for 633-34, read 634-641.

page 608, line 3, for "amounts," read "mounts."

page 616, line 22, for 616, read 614.

page 919, line 28; p. 987, line 42, for "scent gland opening" read "metathoracic spiracle."

page 1028, line 45, for "are" read "is."

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THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN

Volume XXXVIII Part I

Dedicated to

HERBERT BARKER HUNGERFORD

Editor 1933-1940

During his editorship, volumes XXI through XXVI were issued. In 1945-'46, in the absence of the then editor in Asia, Doctor Hungerford edited volume XXX, part 2, and volume XXXI, part 1. Again in 1947 he likewise edited volume XXXII during the absence of the editor in Central America. Due to an oversight his name was omitted as editor from this latter volume.

Through the years Doctor Hungerford has been an active contributor to the Science Bulletin, the first of his articles appearing in volume VIII in 1914. Since that date he has published eleven other papers in the Science Bulletin, two of them studies of monographic extent dealing with cosmopolitan families of insects and involving the greater part of two whole volumes. Other studies on his part are in progress at the present time.

Lawrence, Kansas June, 1956

HERBERT BARKER HUNGERFORD

THE CAREER of Herbert Barker Hungerford, spanning forty-five years at the University of Kansas has been one of inspirational teaching and productive research in his chosen field of entomology. His adult life, devoted almost entirely to one institution, can be measured by the renown and esteem which he has brought to the school whose destiny he has helped to mold. She in turn must acknowledge him as one of her great, one who has added prestige and honor to her accumulated distinction. The name of Hungerford should be rightfully classed with those of Snow, Bailey, Williston, Moore, Stevens, and others, as great Kansans in the field of science.

His is the story of a true son of Kansas. He was born at Mahaska, August 30, 1885, of pioneer stock, the son of Artemus Manwarring and Bertha Estelle (Barker) Hungerford. Early life in a rural community undoubtedly engendered an interest in the living world which remained an abiding passion throughout a distinguished and productive career as educator and man. His early education was obtained in the local Kansas schools and at the Kansas State Normal School (now Kansas State Teachers College) at Emporia. At the onset, family plans anticipated that the son would follow in the father's pattern as landholder and grain operator. Advisers prevailed upon him, however, to validate his teaching certificate with a year's experience, as was then required by State Board of Education regulations. This idea was not entirely foreign to his thinking, for the boy had long been an admirer of his maternal grandfather, George William Barker, who had been principal of the Genoa Academy in Cayuga County, New York state. The necessary year of experience was lengthened into several through jobs as teacher and principal in the school system of Haddam (1904-'06), and later as superintendent of schools at Enterprise (1906-'09).

On August 30 (his birthday), 1905, Hungerford married a college friend, Mary Frances Kenney, of Paola. Their only child, a daughter, Helen Estelle, graduated as an honor student from the University of Kansas in 1930. She is now Mrs. Andrew Benedict Hamilton of St. Petersburg, Fla.

As a teacher Hungerford attended the University of Kansas at Lawrence for the summer sessions and during these enrollments developed his earlier interest in entomology. Giving up his teaching he enrolled at the University as a full-time student in the fall of 1909, receiving his bachelors degree in 1911. During his senior year he was elected to Phi Beta Kappa in recognition of his scholastic achievement. Later (1948-'50) he served this chapter as its president.

Upon receipt of his baccalaureate degree, Hungerford was appointed as an instructor in entomology at the University of Kansas and progressed rapidly up the academic ladder as assistant professor (1913), associate professor (1917), and professor (1920); becoming head of the department of entomology in 1924, a position which he held for twenty-five years. In 1949 he relinquished his administrative duties for what to him was a more interesting life as research professor of entomology, and continued in this capacity until his retirement in 1956.

Doctor Hungerford's continuous service at the University of Kansas was twice interrupted. In 1916 he was granted a year's leave of absence to continue graduate studies at Cornell University where he received his Ph. D. degree in 1918. A trip to Europe in 1928 made possible for him an intense study in the museums of the British Isles and throughout the continent, where he was able to observe and compare type specimens of water bugs, correcting many errors and obscurities in the existing literature. The greater amount of his study was devoted to the museums in London, Berlin, Paris, Budapest, Vienna, and Upsala but none of the lesser collections escaped his careful scrutiny.

Coincident with his duties as departmental head, from 1924-'49 he served as state entomologist and as a member of the Kansas Entomological Commission and the Kansas Horticultural Society.

Summer months were also busy. He participated in biological surveys in the states of Kansas, Colorado, Wyoming, Montana, and Minnesota. He lectured at the University of Minnesota during the summer of 1921 and became a member of the staff of the University of Michigan Biological Station for the summer of 1923, a post which he continued for thirty-one summers, retiring in 1954.

A broad professional experience brought him membership in a variety of professional and learned societies. In addition to Phi Beta Kappa, he was elected during his graduate studies to Sigma Xi and served the Kansas chapter as president (1938-'40). He was a member of the American Association for the Advancement of Science, the Kansas Academy of Science, the Limnological Society of America, and the American Association of Economic Entomologists. An early member of the Entomological Society of America, he was elected as a Fellow in 1929 and as president in 1936 after serving several years as secretary-treasurer. He was elected president of the Society of Systematic Zoology in 1953. Along with others in the area, he was instrumental in the formation of the Kansas Entomological Society and served as president for two terms (1929-'30 and 1938-'40).

His activities were not alone academic or professional. Always a most loyal and congenial friend to those who knew him well, he has a warm and pleasing personality, yet could be somewhat aloof at times of preoccupation. Quick to respond to friendship, he has a subtle and ready wit when appropriate. Many students through the years have been aided financially through his concern and benevolence. His tastes are refined to a point of meticulousness and delicacy, but never has he shown ostentation or personal pride. His recreation sometimes appeared to be forced, as though he begrudged the time away from his research. An occasional game of golf or a week end in the family garden were entered upon reluctantly but actually performed with the same fervor devoted to other phases of his life, all the while excused as a way of maintaining health and vigor. He is a Mason and a regular attendant at Rotary International, serving as president of the local club in 1924-'25. His religion was a matter of deep devotion and faithful inquiry in the Baptist and, later, the Episcopal churches.

As a University staff member, the usual assignment of committee duties fell his lot. Here as elsewhere he devoted his full energies to the tasks at hand, impatient to bring matters to successful completion. Many graduating seniors, not privileged to know him as a teacher, will recall his cheerful and helpful management of the commencement activities during the twenties.

From 1933-'40, Doctor Hungerford served as editor of the UNIVERSITY OF KANSAS SCIENCE BULLETIN. During his editorship, volumes XXI through XXVI were issued and he later acted in this capacity on two occasions in the absence of the regular editor.

Doctor Hungerford's early research was devoted to the ecology and biology of the water bugs, but he found the systematics of the group with which he worked in such a state he felt compelled to solve the uncertainties of nomenclature before pursing his original intent. Perhaps this was fortunate, for he has become the world's authority on the taxonomy of the aquatic Hemiptera. Across the years, by his own collecting or by trade and gift he has amassed the world's largest collection of these insects, enriched largely by the type specimens of his own descriptions along with those which have been compared and found identical with the types in other collections. While his own energies have been concentrated on the Corixidae and Notonectidae where his world monographs are accepted by all as authoritative, he and his students have completely revised most of the genera and families of the aquatic and semiaquatic Hemiptera.

His industry and resulting eminence as an authority in his field are reflected not alone by the hundreds of new species he himself has described and the many papers he has written, but also by the honor implied through the number of species named for him by others; indeed, few modern taxonomists have been so frequently and signally honored in the fashion of fellow systematists in expressing their esteem and respect for a colleague.

Herbert Barker Hungerford has been a dedicated teacher with an inspirational flavor. He himself was endowed with a tenacious memory and a great ambition to excel, coupled with an integrity of mind and purpose which his students could expect only to emulate. His energy and persistence are legend and a constant example to his many students and colleagues. He has always approached life and its vagaries with modesty but enthusiasm. His retirement as an active teacher brings to a close a long and fruitful career in the academic world of the classroom, but he has expressed his intent in a recent interview when he said, "My salary is retiring, I am not. If I have about ten more years of good health I ought to clear up my special field, so far as taxonomy is concerned."

May he have good health, and happiness in the memory of a great life, well lived.

LAURENCE C. WOODRUFF.

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THE UNIVERSITY OF KANSAS
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A Review of the Lizards of Costa Rica

BY

EDWARD H. TAYLOR *

ABSTRACT. The lacertilian fauna of Costa Rica is reviewed on the basis of collections made by the author on four Costa Rican expeditions. The fauna is discussed and listed. The following forms are described as new: *Anolis humilis marsupialis, Anolis woodi attenuatus, Anolis biscutiger, Anolis aquaticus, Anolis achilles, Ameiva festiva occidentalis, Leiolopisma cherriei lampropholis, Mabuya brachypodus.* Altogether seventy-nine species and subspecies are treated. Each form is described and for the most part illustrated by photographs.

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INTRODUCTION

Of the fourteen families of lizards now recognized in the Western Hemisphere eight are known in Costa Rica. These are the Eublepharidae, Sphaerodactylidae, Anguidae, Teiidae, Gekkonidae, Xantusiidae, Iguanidae, and Scincidae. These differ considerably in the number of genera and species represented, varying from three species (one genus) in the Xantusiidae to 36 forms and seven genera in the Iguanidae. Some of the families are confined chiefly to the lowlands, while others—Iguanidae and Anguidae—may have representatives up to the tops of the highest mountains.

The Western Hemisphere families, absent in Costa Rica, are the Anelytropsidae, Bipedidae, Aniellidae, Xenosauridae, and Helodermatidae. The Amphisbaenidae, sometimes placed in the Sauria, are absent. All occur in Mexico, but the number of representatives have dwindled and they may be regarded as relicts. If they have ever occurred in Central America or in the Eastern Hemisphere they have become extinguished there.

The following families of the fourteen mentioned above occur outside of the Western Hemisphere: Eublepharidae, with representatives in Asia and Africa; Anguidae, with legless forms in Asia, Indonesia, Europe and Africa; Iguanidae with a few forms in Madagascar, and the Fiji and Friendly Islands. The Gekkonidae and Scincidae are widespread in the Eastern Hemisphere, and comprise numerous genera and species.

Judging by the present distribution of the Teiidae we presume that this family has developed and evolved chiefly in South America. A few of its numerous genera have reached Costa Rica while two of its more progressive genera have reached northern Mexico. One of these, *Cnemidophorus,* has become widespread in the United States.

Distribution of Costa Rican Genera of the Sauria

	United States	Mexico	Guate-mala	Costa Rica	Panama	South America	Eastern Hemi-sphere
Coleonyx	X	X	X	X	X	....	....
Lepidoblepharis	....	....	....	X	X	X	....
Gonatodes	....	X	X	X	X	X	....
Sphaerodactylus	....	X	X	X	X	X	....
Thecadactylus	....	X	X	X	X	X	....
Phyllodactylus	X	X	X	X	X	X	X
Anolis	X	X	X	X	X	X	....
Polychrus	....	....	....	X	X	X	....
Corythophanes	....	X	X	X	X	X	....
Basiliscus	....	X	X	X	X	X	....
Iguana	....	X	X	X	X	X	....
Ctenosaurus	....	X	X	X	X	....	....
Diploglossus	....	X	X	X	X	X	....
Celestus	....	X	X	X	....	....	....
Barisia	X	X	X	X	....	....	....
Lepidophyma	....	X	X	X	X	....	....
Gymnophthalmus	....	X	X	X	X	X	....
Leposoma	....	....	....	X	X	X	....
Anadia	....	....	....	X	X	X	....
Ptychoglossus	....	....	....	X	X	X	....
Ameiva	X	X	X	X	X	X	....
Cnemidophorus	X	X	X	X	X	X	....
Leiolopisma	X	X	X	X	X	....	X
Eumeces	X	X	X	X	....	....	X
Mabuya	....	X	X	X	X	X	X

That South American genera other than the ones listed may be represented in Costa Rica is a strong probability. This is especially true for certain Teiid and not impossibly Iguanid groups. *Echinosaura* and *Scolecosaurus,* Teiid genera, are known to occur in Panamá.

The most striking feature of the lizard fauna is the remarkable series of species and subspecies that has developed in the genus *Anolis.* These vary from small inconspicuous terrestrial forms, to large showy arboreal creatures. Because of the large number of species inhabiting Costa Rica, one is convinced that the genus as now generally regarded is a composite, one actually composed of several genera. In certain cases these species-group differences have prompted workers to propose generic or subgeneric names for them—*i. e. Draconura, Coccoëssus, Gastrotropis,* etc. While eventually this great unwieldly composite genus must be broken up, one must examine in some considerable detail the entire series of real and nominal species before it can be attempted. It would be preferable that the task be done by other than an amateur worker—one who can give the problem adequate study in the field.

As in the case with other herpetological groups, the data available on Costa Rican Sauria are scattered in the literature. There is some confusion owing to the fact that a single species may have been described by two or more persons either due to inadequate literature or inaccessibility to the literature. Our knowledge of the fauna has been of slow growth. Often the species has been described from a place outside of Costa Rica and the discovery in the latter country may have happened at a much later date.

I have previously reported on certain parts of the collections from Costa Rica (see bibliography). However, only two of these (Taylor 1949 and 1955) deal with lizards.

HISTORY OF COLLECTIONS AND LITERATURE

Of the eighty species and subspecies of Sauria treated in this work, Cope, as early as 1871, listed eight species collected in Costa Rica. *Anolis insignis, Anolis macrotus* and *Anolis trochilus* [= *Anolis limifrons* Cope] were described as new. Besides these the following names also appeared: *Anolis nannodes* var. Cope, *Anolis hoffmani* Peters, *Sceloporus malachiticus* Cope, *Cyclura acanthura* Wiegmann, and *Phyllodactylus* (not identified as to species). This collection, obtained from Dr. Van Patten, was derived from the country in the neighborhood of the city of San José, capital of the Country, several specimens perhaps coming from the southern and western slopes of Volcán Irazú.

A second and more considerable collection sent to the United States was made by William Gabb—"under the auspices of the government of Costa Rica, was obtained in the southern portion of the region of Costa Rica which lies east of the elevated mountain range, which traverses that country, and at different elevations on the range itself."

Certain of the specimens were obtained on Pico Blanco, a peak rising to an elevation of (*circa*) 11,800 feet. Cope states that most of the lizards were taken at Sipurio, a point on Río Sixaola about eighteen air miles from the nearest coast, close to the Panamá border, and having an elevation of some 200 feet.

In this paper (Cope 1875) the following species were described as new: *Anolis pachypus, Anolis oxylophus* [= *Anolis lionotus* Cope], *Basiliscus plumifrons, Mabuia alliacea* [= *Mabuya alliacea* Cope], *Chalcidolepis metallicus* new genus, new species [= *Anadia metallica metallica* Cope]; *Amiva gabbiana* [= *Ameiva quadrilineata* Hallowell]. Aside from the new forms, the following were listed, those appearing in the previous list are preceded by an asterisk: *Coleonyx elegans* Gray [= *Coleonyx mitratus* Peters], **Phyllodactylus* sp., *Sphaerodactylus glaucus* Cope [= ?], *Thecadactylus rapicaudus* Houttuyn, **Anolis microtus* Cope, **Anolis insignis* Cope, **Anolis trochilus* Cope [= *Anolis limifrons* Cope], *Anolis intermedius* Peters, *Anolis capito* Peters, *Anolis tessellatus* O'Shaughnessy [= *Anolis intermedius* Peters], *Polychrus multicarinatus* Peters [= *Polychrus gutturosus* Berthold], *Iguana rhinolopha* Wiegmann, *Cyclura acanthura* Wiegmann [= *Ctenosaurus similis similis* Gray], *Basiliscus vittatus* Wiegmann, *Sceloporus malachiticus* Cope [= *Sceloporus malachiticus malachiticus* Cope], *Diploglossus monotropis* Kuhl, *Gerrhonotus fulvus* Bocourt [= *Barisia monticola* Cope], *Amiva festiva* Lichtenstein and von Martens [= *Ameiva festiva festiva* Lichtenstein and von Martens], *Mocoa assata* Cope [= *Leiolopisma cherriei lampropholis* subsp. nov.], *Mabuia cepedei* [= ?].

Cope omitted two names, *Anolis nannodes* var. [= *Anolis intermedius* Peters] and *Anolis hoffmani* [= *Anolis cupreus* Hallowell], appearing in his first list. Cope, in 1877, described the form listed above as *Gerrhonotus fulvus* Bocourt, as *Barisia monticola* sp. nov.

Cope's Catalogue of Batrachia and Reptiles of Central America and Mexico appeared in 1887 and in it are listed thirty-one forms. A few changes are made in the names.

Mabuia cepedei Gray appears in the synonymy of *Mabuia agilis* Raddi = (?). *Anolis nannodes* Cope [= *Anolis intermedius* Peters] and *Anolis hoffmannii* [= *Anolis cupreus* Hallowell] are restored to the list, and two forms described by Boulenger in 1886 are added —*Anolis tropidolepis* and *Anolis godmani*. Cope's species *Chalcidolepis metallicus* is reported under *Leposoma metallica* Cope. *Celestus bilobatus* O'Shaughnessy (*in* Bocourt) is listed, and *Sceloporus squamosus*, and *Basiliscus americanus* Laurenti [= *Basiliscus basiliscus* Linnaeus] also appear.

Thus seven names are added to the Costa Rican list, and one is placed in synonymy making a net gain of six.

In 1893 Cope published on a collection made in southwestern Costa Rica by Mr. George K. Cherrie. In this were described as new, the following species: *Mocoa cherriei* [= *Leiolopisma cherriei cherriei* Cope], *Amiva leptophrys* [= *Ameiva leptophrys* Cope], and *Anolis longipes* [= *Anolis capito* Peters].

The following also were listed: *Gymnophthalmus laevicaudus* Cope [= *Gymnophthalmus speciosus speciosus* Hallowell], *Amiva quadrilineatus* [= *Ameiva quadrilineatus* Hallowell], *Amiva festiva*

Lichtenstein and von Martens [= *Ameiva festiva occidentalis* subsp. nov.], *Celestus Steindachneri* [= *Celestus ?*], *Ctenosaurus* yg; *Iguana tuberculata* Linnaeus, *Anolis intermedius* Peters, *Anolis trochilus* Cope [= *Anolis limifrons* Cope], *Basiliscus vittatus* Wiegmann.

In 1894 *Cnemidophorus amivoides* [= *Ameiva undulata parva* Barbour and Noble], *Cnemidophorus alfaronis* and *Celestus cyanochloris* were described by Cope and in a posthumous paper (1899, edited by J. Percy Moore), he described *Anolis purpurescens* from Colombia.

Wilhelm Peters (1863) described two Costa Rican species collected by Dr. C. Hoffman, *Anolis hoffmannii* and *Anolis capito*, and two Panamanian species, *Anolis intermedius* and *Anolis humilis*, later to be reported from our territory. Later the same year, he described a specimen collected by Dr. A. von Frantzius as *Brachydactylus mitratus* [= *Coleonyx mitratus* (Peters)]. In 1869 he described *Polychrus* (*Chaunolaemus*) *multicarinatus* [= *Polychrus gutturosus* Berthold]. In 1873 (or 1874) Peters described several Panamanian forms, among which were *Anolis polylepis* and *Anolis obtusirostris* [= *Anolis biporcatus* Wiegmann] later to be found in Costa Rica. These names appeared in Cope's papers.

Albert Günther, 1885-1893, in the Biologia Centrali-Americana: Reptilia and Batrachia, listed thirty forms most of which had appeared in Cope's papers. The following, however, had not been listed: *Ameiva surinamensis* Laurenti [= ?], *Ameiva undulata* [= *Ameiva undulata parva* Barbour and Noble]; *Anolis cupreus* Hallowell, and *Anolis intermedius* Peters. This work was largely based on collections made in Central America by Salvin and Godman chiefly in Mexico and Guatemala.

George Albert Boulenger, 1885-1886, described or reported from Costa Rica, *Anolis godmani** [= ?] and *Anolis tropidolepis*. In 1893 *Anolis curtus* was described.

Emmet Reid Dunn added the following names to the known fauna: *Anolis humilis* Peters, *Anolis stigmosus* Bocourt, *Anolis altae* sp. nov., *Anolis lionotus* Cope, *Anolis limifrons* Cope, *Anolis pentaprion* Cope. He also described *Anolis woodi* from Panamá (here reported for the first time from Costa Rica). These descriptions were based on material collected by him for the Harvard Museum.

Charles Burt, 1931, reports *Sceloporus variabilis* [= *Sceloporus*

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* Regardless as to whether the description of *Anolis godmani* in the Biologia Centrali-Americana: Reptilia and Batrachia (dated October 1885) appeared before that in Boulenger's Catalogue (1885) is entirely immaterial since his placing of the Boulenger reference (as yet unpublished) following the name, gives conclusive evidence of authorship.

variabilis olloporus Smith] and *Cnemidophorus deppei deppei* and in the same year shows the presence of *Cnemidophorus lemniscatus lemniscatus* occurring in Costa Rica in his distributional map.

Burt has also reported *Epaphelus sumichrasti* (in synonymy) from Costa Rica.*

My studies on the Costa Rican fauna began in 1947 when, accompanied by my son, Richard Clark Taylor, I made my first Costa Rican sojourn. This was followed by a second journey in 1951, a third in 1952, and a fourth in 1954, the last three being undertaken alone. The four expeditions allowed for a total of ten months in the field during which I acquired, for the collections of the University of Kansas, more than ten thousand specimens. These, together with specimens collected by Richard Clark Taylor, have been available for my studies. A fair proportion of the collections are represented by Sauria. I have examined only a part of the Costa Rican specimens in other collections of the United States, since much of the critical material was not available to me at the time this work was being prepared.

Very much work still needs to be accomplished before a complete report on the Saurian fauna of this region will be written. However, since no work purporting to cover this fauna has appeared since Boulenger's catalogues 1885-1886, a period of seventy years, I offer this resumé as a contribution to our present knowledge. I am aware of numerous forms that, with adequate material, will eventually be designated as subspecies. And doubtless there are others that have not been seen by me. Others already described now appearing in synonymy may be revived, and some now recognized may be again relegated to the oblivion of synonymy. New species, too, will surely be discovered.

I have published two papers that include descriptions of Costa Rican saurians: one (Taylor, 1949) describes *Alopoglossus plicatus* [= *Ptychoglossus plicatus*] and *Leposoma bisecta* [= *Leposoma southi southi* Ruthven and Gaige]; a second (Taylor, 1955) describes *Anadia metallica attenuata, Anadia metallica arborea, Leposoma southi orientalis, Lepidophyma reticulatum, Lepidophyma anomalum* [= *Lepidophyma obscurum* Barbour] and *Lepidophyma ophiophthalmum. Eumeces managuae* Dunn is reported for the first time in Costa Rica.

In the present work the following species are described as new:

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* This reference is in error, since Dr. Burt has seemingly considered the presence of the description of this species in Cope's 1875 paper, in a footnote, as evidence of its occurrence in Costa Rica.

Anolis humilis marsupialis, Anolis woodi attenuatus, Anolis biscutiger, Anolis aquaticus, Anolis achilles, Ameiva festiva occidentalis, Leiolopisma cherriei lampropholis, Mabuya brachypodus.

The following are presumably here reported from Costa Rica for the first time: *Gonatodes fuscus* Hallowell, *Sphaerodactylus homolepis* Cope, *Sphaerodactylus millipunctatus* Hallowell, *Phyllodactylus eduardofischeri* Mertens, *Anolis purpurescens* Cope, *Anolis polylepis* Peters, *Anolis lemurinus lemurinus* Cope, *Anolis woodi woodi* Dunn, *Basiliscus galeritus* A. Duméril, *Gymnophthalmus speciosus speciosus* Hallowell, *Mabuya unimarginata* Cope.

In this report I am including numerous figures to aid in the identification of species, since many have not been figured, and of those that have, many are in books that are not readily accessible. Many of my figures are satisfactory save for color; others less so, but even these I believe are better than no figure at all.

Costa Rica, together with much of western Panamá, constitutes a landmass that in former times may have formed an ancient island. The low land of the Canal Zone and of the Nicaraguan border may well have been below sea level, thus isolating it from landmasses northward and eastward. The Cordillera Volcanica and the Cordillera Central are separated by the relatively high Meseta Central (about 1500 meters at its highest part) from the Talamanca Range that extends into western Panamá. The Meseta does not completely separate the faunas in the two areas. Several Panamanian species, as yet unknown in our territory, may be discovered eventually.

While many parts of the country have been visited and partially explored, much work still must be accomplished, especially in the southern mountains at elevations between 800 and 2,800 meters. There are two other regions—the Peninsula de Nicoya, Western Guanacaste, and the Peninsula de Oso, Puntarenas Province, that have escaped exploration. These two areas may once have been detached from the mainland and their faunas may have undergone change as a result of isolation.*

TAXONOMY OF COSTA RICAN SAURIA

KEY TO THE FAMILIES OF SAURIA IN COSTA RICA

1. Body and top of head covered with small granules and/or scales but lacking typical symmetrical plates on top of head 2
   Body covered with granules or scales but top of head covered with symmetrical shields or plates 4

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* A discussion of the geography of Costa Rica has appeared in a previous paper. See Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 2, 1951, pp. 12-16.

2. Vertebrae amphicoelous, "spectacle" covering eye, no fovea; postanal sacs and bones present; femoral and preanal pores may be present or absent (absent in endemic forms in Western Hemisphere), Gekkonidae

Vertebrae procoelous; eye-covering variable 3

3. True upper and lower eyelids present, without "spectacle"; parietal bones united; pupil vertical; postanal sacs and bones present; typical preanal pores in male .... Eublepharidae

"Spectacle" covering eyes, without true eyelids; postanal sacs and bones absent; parietals paired; pupil rounded (in Costa Rican forms), Sphaerodactylidae

4. No eyelids; eyes permanently open 5

Eyelids present, movable; scales generally cycloid, with or without keels, more or less similar above and below 8

5. Inner finger absent; scales cycloid in about thirteen rows about middle of body; nasal plates separated (*Gymnophthalmus*) .... Teiidae

Inner finger present; scales variable; three or four supraoculars 6

6. Body covered on dorsum and sides with granules; venter with six to ten longitudinal rows of enlarged scutes; a few enlarged scutes on arms and legs (*Ameiva, Cnemidophorus*) .... Teiidae

Body not covered with granules, or *if* granular, intermixed with tubercles and the enlarged supraoculars lacking 7

7. Body covered with scales on dorsum, sides, and venter; supraoculars present (*Leposoma, Ptychoglossa, Anadia*) .... Teiidae

Body tubercular or granular, intermixed with larger tubercles; no enlarged supraoculars; the frontal divided mesially and occupying supraocular area; lower labials and chinshields fused .. Xantusiidae

8. A lateral groove or fold with fine granules strongly differentiated from enlarged ventral scales (*Barisia*) .... Anguidae

No groove or fold along side of body 9

9. Only one scale touches frontal anteriorly; two rows of supraoculars (outer row may consist of only one or two scales) (*Celestus, Diploglossus*) .... Anguidae

Two or three scales touch frontal anteriorly, or frontal not distinguishable; with more than 15 scales on top of head 10

10. Fewer than 20 enlarged scales on top of head; two or three scales border frontal anteriorly; scales on dorsal, lateral and ventral surfaces cycloid, subequal, in longitudinal rows .... Scincidae

More than 20 scales on top of head; scales variable, large imbricate scales, or minute juxtaposed scales or granules on dorsum, sides and ventrals .... Iguanidae

SUPERFAMILY GEKKONOIDEA

Until further researches are undertaken it seems wise to follow the classification of the gekkonoid lizards offered by Garth Underwood.*

Following this arrangement Costa Rican forms will be arranged as follows:

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* Proc. Zool. Soc. London, vol. 124, pt. 3, Nov. 1954, pp. 469-492.

- Family—Eublepharidae
  - Genus—Coleonyx Gray
    - Coleonyx mitratus Peters
- Family—Sphaerodactylidae
  - Genus—Lepidoblepharis Peracca
    - Lepidoblepharis xanthostigma Noble
  - Genus—Gonatodes Fitzinger
    - Gonatodes fuscus Hallowell
  - Genus—Sphaerodactylus Wagler
    - Sphaerodactylus pacificus Stejneger
    - Sphaerodactylus homolepis Cope
    - Sphaerodactylus lineolatus Lichtenstein and von Martens
    - Sphaerodactylus imbricatus Andersson
    - Sphaerodactylus millepunctatus Hallowell
    - Sphaerodactylus sp. (tail).
- Family—Gekkonidae
  - Subfamily—Gekkoninae
    - Genus—Thecadactylus Cuvier
      - Thecadactylus rapicaudus Houttuyn
    - Genus—Phyllodactylus Gray
      - Phyllodactylus edwardofischeri Mertens

The presence in Costa Rica of a species of *Aristelliger* (subfamily Diplodactylinae *fide* Underwood) is problematical. Boulenger (Catalogue of the lizards in the British Museum, vol. 3, Addenda to vol. 1) gives Nicaragua as representing a part of the range of the genus. If this data is correct, this genus may extend into Costa Rica. As yet I have learned of no specimen that has been found in the latter country.

Imported species of the genus *Hemidactylus,* although occurring both north and south of Costa Rica, seemingly have not entered the country.

KEY TO FAMILIES OF THE GEKKONOIDEA IN COSTA RICA

1. Vertebrae amphicoelous; spectacle covering eye; no fovea; three or four pairs of sternal ribs; postanal sacs and bones present; femoral and/or preanal pores present or absent (absent in endemic forms in the Western Hemisphere) (subfamily Gekkoninae) . . . GEKKONIDAE

Vertebrae procoelous; eye-covering variable 2

2. True upper and lower eyelids present without spectacle; parietals united; pupil vertical; postanal sacs and bones present. Typical preanal pores in male. . . . . EUBLEPHARIDAE

Spectacle covering eye; without true eyelids; postanal sacs and bones absent; parietals paired; pupil rounded in Costa Rican forms. SPHAERODACTYLIDAE

FAMILY EUBLEPHARIDAE Boulenger

Eublepharidae Boulenger, Ann. Mag. Nat. Hist. ser. 5, vol. 12, 1883, p. 308; and ser. 5, vol. 14, 1884, p. 119.

Vertebrae procoelous; parietal single; body covered with small scales or granules; eyes with vertically elliptic pupil and thick movable upper and lower eyelids; males with typical preanal pores; digits straight, slender, lacking lamellae; postanal sacs and bones present. Two eggs are laid. A voice mechanism present.

Boulenger writing of this group (1885 Catalogue, vol. I, p. 229) states: "Three species are native of Central America, one of the southern parts of the United States, two of Southern Asia, and one of West Africa; the genus *Eublepharis* occurs in America as well as in Asia. This extraordinary distribution seems to indicate that a few representatives of this small family are the remnants of some ancient, more generally dispersed group; it never-the-less remains a matter of wonder how forms, now so widely separated, have retained so great a resemblance, not only in structure, but also in the pattern of coloration."

While the concept of the genera and species belonging to the group has changed somewhat, Boulenger's comment is still worthy of repetition.

Underwood recognizes the following genera as members of the family Eublepharidae:

Aeluroscalabotes Günther. Malaya, Borneo, Sumatra.

Eublepharis Gray. Southwest Asia, including Hainan and Riu Kiu Islands.

Hemitheconyx Stejneger. W. Africa and Somaliland.

Holodactylus Boettger. Somaliland.

Coleonyx Gray. Southwestern U. S. to Panamá.

Only the latter genus occurs in the Western Hemisphere. Endemic American members of the Gekkonidae and of the Sphaerodactylidae seemingly have not developed true preanal and femoral pores.* True preanal pores are present in this family.

Genus COLEONYX Gray

Coleonyx Gray, Ann. Mag. Nat. Hist., ser. 1, vol. 16, 1845, p. 162 (type of genus *Coleonyx elegans*).

Description of genus: Body covered with granular or tubercular scales, intermingled with larger tubercles; digits slender short without widened lamellae; abdominal scales strongly imbricate, with a series of preanal pores in males; no femoral pores.

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* The presence of *Hemidactylus* in the Western Hemisphere is, I believe, due to importation in historic time by man.

This genus (as recognized in Klauber's revision, 1945) ranges from the southern part of Texas, west to California (including Utah and Nevada), through northern and western Mexico, south into Durango, Sinaloa and Baja California. After a considerable break in Mexico in the known distribution, a southern group begins in Central Veracruz and Colima, and following the lowlands, extends south through Central America to Panamá. I am not aware that there is contact anywhere between the two groups.

These two groups are distinct, and seemingly the differences are of such a character as to warrant a separation into two genera.

The name *Coleonyx* properly belongs to the southern group. It consists of two species, *Coleonyx elegans* with two subspecies, and *Coleonyx mitratus* with two forms *mitratus* and *dovii*. Only a single form, *Coleonyx mitratus* Peters, is known to occur in Costa Rica.

Coleonyx mitratus (Peters)

(Fig. 1)

Brachydactylus mitratus Peters, Monatsb. Akad. Wiss. Berlin, 1863, pp. 41-44 (type locality, Costa Rica).

Coleonyx elegans Bocourt, *part.*, Mission Scientifique au Mexique et dans l'Amérique Central; Études sur les Reptiles, livr. 2, 1873, p. 49 (includes *mitratus* in synonymy); Cope, Journ. Acad. Nat. Sci. Philadelphia, 2nd ser., vol. 8, 1876 (1875) p. 118; Proc. Amer. Philos. Soc., June 20, 1879, p. 271; Wettstein, Sitzungsb. Akad. Wiss. Wien, Math-natur. Klasse, Abt. 1, Bd. 143, Heft 1, 2, 1934, pp. 19-20 (Bebedero; Central Plateau in the vicinity of San José).

Eublepharis dovii Boulenger, Catalogue of the lizards in the British Museum (Natural History), vol. 1, 1885 (type locality Panamá); Günther, Biologia Centrali-Americana; Batrachia and Reptilia, 1890, Feb., pp. 83-84, pl. 31, fig. 13.

Coleonyx dovii Stejneger, North Amer. Fauna, no. 7, 1893, p. 163.

Coleonyx mitratus Schmidt, Field, Mus. Nat. Hist. Zool. Ser., vol. 12, 1928, no. 16, p. 194; Klauber, San Diego Soc. Nat. Hist., vol. 10, no. 11, Mar. 9, 1945, pp. 199-203, map; Mertens, Abh. Senckenb. naturf. Ges. No. 487, 1952, pp. 37-38, pl. 11, fig. 63 (El Salvador).

Diagnosis: Rostral bordering the lip for a greater distance than mental, the first infralabial in contact with mental; femoral pores present, usually 5-9, 7 or 8 being most frequent; scalerows on venter, 27-29; nostril wholly in nasal scale, not bordered by the internasal; tips of claws strongly visible.

Description (From KUMNH No. 34180 Tenorio, Las Cañas, Guanacaste, Costa Rica): Rostral large, its width (2.2 mm.) greater than its height (1.7 mm.), occupying a longer border on lip than mental; the first lower labial not in contact with rostral when mouth is closed; two internasals border rostral, their narrowest width is only slightly more than half their greatest length; nostril included in a single nasal; nasal followed by two small and four minute scales; nine scales along the posterior borders of internasals; about ten irregular scalerows between nostril and eye; scales on snout larger, somewhat hexagonal with a few smaller irregular scales; between the orbits the larger scales are reduced in number and there are more numerous smaller ones; some granules between scales; between the edges of eyelids at middle of orbit about 55 scales; scales along outer edges of eyelids a little enlarged; eyelids

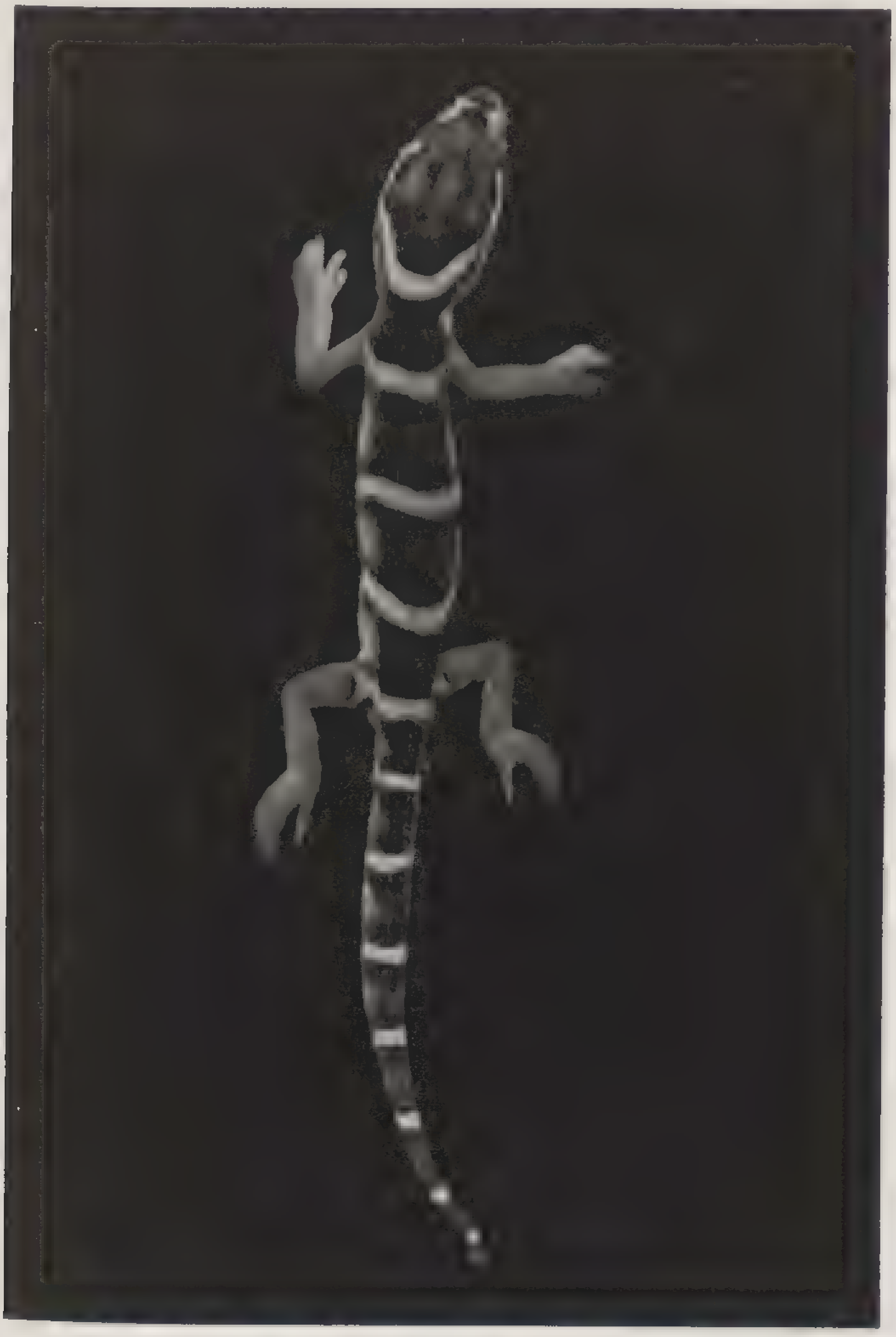

Figure 1. *Coleonyx mitratus* Peters (juvenile). KUMNH No. 34180 (young); Tenorio, Las Cañas, Guanacaste, C. R.; actual total length, 96 mm.

distinct, functional, the upper separated from the interorbital area by two very minute scalerows in which some scales are absent; 22 scales in a row across snout between the second labials; ear-opening large, nearly twice as long as wide normally; 7-7 supralabials, last very small; 6-6 infralabials; mental rather rounded posteriorly, followed by four scales, one separated from the others because of minute intercalated granules.

Dorsal squamation granular, interspersed with tubercles similar to those between orbits, but tubercles are a little more elevated and a little larger, arranged in about 24 irregular rows across back, and from 22-26 in a longitudinal line from vent to axillary level; scales on venter larger, imbricate, arranged in 24-26 rows, all larger than scales on chin and neck; eight preanal scales bearing pores; edge of vent without enlarged scales; openings of the postanal sacs distinct; a single large anal tubercle on each side of vent; tail segmentation indicated by whorls of eight tubercles, usually distinct at base, but less distinct distally where the tubercles are reduced in number; each segment with six rows of scales (rarely part of another present); on ventral part of tail larger scales alternate with one or two pairs of smaller scales.

Arms and legs relatively short, the tip of longest toe not reaching elbow of adpressed arm; fingers short, covered below with thickened, widened scales, 12 under fourth fingers; tips with a sheath formed of three scales that fail to cover completely the retracted claw, leaving much of claw exposed; 18 scales under fourth toe; arm covered largely with flat imbricate scales without distinct tubercles; legs with flat imbricate scales except on dorsal side of tibia and dorsal and posterior face of thigh.

Color in life: Brownish to brownish black above, with the curved and transverse bands on body whitish yellow dorsally, becoming cream laterally; lips spotted; chin and throat cream; flesh-white on venter and on light areas under tail; laterally the lighter ventral color encroaches on the black blotches; dark mark on top of head with some light brown areas evident.

Measurements in mm.: Snout to vent, 50; tail, 46; axilla to groin, 24.3; snout to foreleg, 22; snout to ear, 12; head width, 9; head length, 15.

Remarks: A second specimen, obtained at San Isidro del General, is larger. The brown markings of the head are much lighter and the lateral encroachment of the light color on the dark blotches has proceeded farther.

Records of the species for Costa Rica are as follows: San José, Province: San Isidro del General, Tableland near San José, San José. Guanacaste Province: Bebedero, an island in the Gulf of Nicoya, and Tenorio. Cartago Province: Turrialba.

Most of the localities for the species are in the Pacific drainage area. The exception is Klauber's (1945) record for Turrialba. In my collecting at Turrialba, and in the Turrialba area, I have not succeeded in finding it.

Don Jose Zeledón reported to Cope that the species was to be found in ant-hills near San José. If this is a natural habitat, it may account for the apparent rarity.

It is called *perro sonpopo* and is regarded as dangerous. Needless to say it is a completely harmless animal. The specimen described was found by John Baker under a small board in a forested area.

FAMILY SPHAERODACTYLIDAE Underwood

Sphaerodactylidae Underwood, Proc. Zool. Soc. London, vol. 124, pt. 3, November 1954, p. 476.

The recent proposal of Underwood to distinguish a group of small saurian genera under the above name is followed here. His definition of the family is:

"Spectacle covering eye; second branchial arch nearly complete; interruption between base—and epibranchial; vertebrae procoelous; clavical perforated or not. Four or five pairs of sternal ribs; digital pads, if present single, terminal; temporal fovea. Postanal sacs and bones absent; no femoral or preanal pores; parietals paired; pupil round, elliptical or straight vertical."

To the above characters may be added: no voice mechanism present; a single egg produced; in Costa Rican genera, males with a larger or smaller series of differentiated glandular scales in preanal ventral region and often with similar series on femora, rarely in postanal region; no eyelids, but extrabrillar fringe continuous, surrounding eye, becoming more extensive over the anterior part of eye.

The Costa Rican genera belonging to this family are *Gonatodes*, *Lepidoblepharis* and *Sphaerodactylus*. Two other genera, *Pseudogonatodes* * and *Coleodactylus*,* recognized as members of the family are South American.

All specimens of the Costa Rican genera examined have a rounded pupil, and the males are equipped with specialized glandular scales probably subserving the same function as femoral and preanal pores and not impossibly the ancestral type of such pores.

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* The presence of glandular scales have not been demonstrated in these genera.

KEY TO THE COSTA RICAN GENERA OF THE SPHAERODACTYLIDAE

1. Claws not retractile into a sheath; distal portion of digit compressed and forming an angle with the more proximal parts . . . . *Gonatodes*
   Claws retractile into a sheath 2
2. Each digit terminating in an asymmetrical lamella,* at the proximal side of which the claw is retractile into a sheath . . *Sphaerodactylus*
   Each digit terminating in a symmetrical sheath composed of six scales into which the claw is withdrawn . . . . *Lepidoblepharis*

Genus LEPIDOBLEPHARIS Peracca

Lepidoblepharis Peracca, Boll. Mus. Torino, vol. 12, no. 300, 1897, p. 1 (type, by monotypy, *Lepidoblepharis festae* Peracca).

Lathrogecko Ruthven, Occ. Papers Mus. Zool. Univ. Michigan, no. 21, 1916, p. 1 (type, *Lepidoblepharis sanctae-martae* Ruthven).

Description of genus: "Digits short or moderate, cylindrical, the distal joints forming an angle with the basal portion, with smooth transverse lamellae inferiorly; claw retractile vertically into a large compressed sheath composed of six scales—a pair of elongate infero-laterals in contact inferiorly, a pair of elongate supero-laterals, an elongate median dorsal separating the latter, and a small terminal lying in the angle between the tips of the supero-laterals. Head and neck covered with small granular scales; body depressed, tail round; ventral and inferior caudal scales smooth, imbricate; dorsals granular, tubercular or imbricate. Pupil round; eyelid well developed above. Rostral shield large, with a U-shaped impression on its upper surface. Clavicle moderately dilated, not perforated. Male without femoral pores." Parker, 1926, redefinition.

To the above characters must be added: males with a series of specialized "glandular" preanal and (frequently) femoral scales. Vertebrae procoelous. One egg produced.

This genus of small gekkoes ranges from southern Central America into northwestern South America; at least seven species are currently recognized, only one of which has been reported from Costa Rica. This is a small terrestrial gekko living for the most part under rotting logs or trash, usually in moist situations.

Lepidoblepharis xanthostigma Noble

(Figs. 2, 3)

Lathrogecko xanthostigma Noble, Proc. Biol. Soc. Washington, vol. 29, April 4, 1916, pp. 87-88 (type locality, Zent, near Puerto Limón, Costa Rica, H. S. Blair collector); Amer. Mus. Novitates, no. 4, Mar. 10, 1921, pp. 3, 6, fig. 3 (skeletal characters).

Lepidoblepharis xanthostigma Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 8, June 7, 1933, p. 75 (El Valle de Anton, Panamá); Proc. Acad. Nat. Sci. Philadelphia, vol. 92, 1940, p. 112 (Costa Rica: Suretka, Monteverde, Guápiles, Carillo, "La Castilla farm on the lower Reventagón *sic* (= Reventazón). Panamá: "Cerro Campana", about 3,000 ft., El Valle); Parker, Ann. Mag. Nat. Hist., ser. 9, vol. 17, 1926, pp. 291-301 (relationship); Underwood, Proc. Zool. Soc. London, vol. 124, pt. 3, Nov. 1954, p. 476 (member new family Sphaerodactylidae).

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* This scale is described in the literature as spherical. At least this is usually untrue.

Diagnosis: Diminutive gekkoes, probably not exceeding 38 mm. in snout-vent length; rostral dorsally flattened with an inverted U-shaped ridge; toes symmetrical, the claws retractile into sheaths composed of six scales; "escutcheon" consisting of numerous glandular scales; femora with or without some similar scales; fringe of eye "spectacle" forms a shelflike projection bordered by much-enlarged scales.

Description of species (From KUMNH No. 38926, Limón): Head a pointed oval, the eyes moderately prominent; rostral large, flattened on top, the flat area bordered by an inverted slightly elevated U-shaped ridge that extends onto the internasals, the flattened portion cut by a suture, no part of scale extending posterior to middle of nostril; internasals enlarged, wider than long, separated by two scales, one behind the other; nostril surrounded by rostral, internasal and one or two postnasals border rim; snout without a canthus rostralis, rounded transversely, covered with juxtaposed flat scales diminishing in size from the internasals to between eyes; first supralabial very large, more than twice as long as high, more than twice the size of second, highest near the middle of scale; this followed by four differentiated supralabials, rapidly diminishing in size; remainder of mouth-border edged with minute granular scales; rostral large, flattened posteriorly with a labial border considerably greater than that of mental; first infralabial only a little larger than second, which in turn is three to four times size of third; latter followed by three other small infralabials diminishing in size; mental bordered behind by five scales, the three median largest; following this row the scales diminish rapidly in size and the chin and anterior part of throat are covered with small nearly equal-sized juxtaposed flat granules.

Eye surrounded by a "spectacle" and fringe which on upper anterior three fourths forms a shelflike projection, bordered by enlarged scales; posteriorly these are flattened pointed scales, while anteriorly there are three enlarged ciliary scales, the very large median scale double the size of the others and as wide but not quite so long as second supralabial; below this row of scales is a horizontal row of subciliary scales also bordering the edge of "spectacle"; on lower edge of orbit, touching the supralabials but lying mostly within the orbit, is a series of five differentiated scales, dark

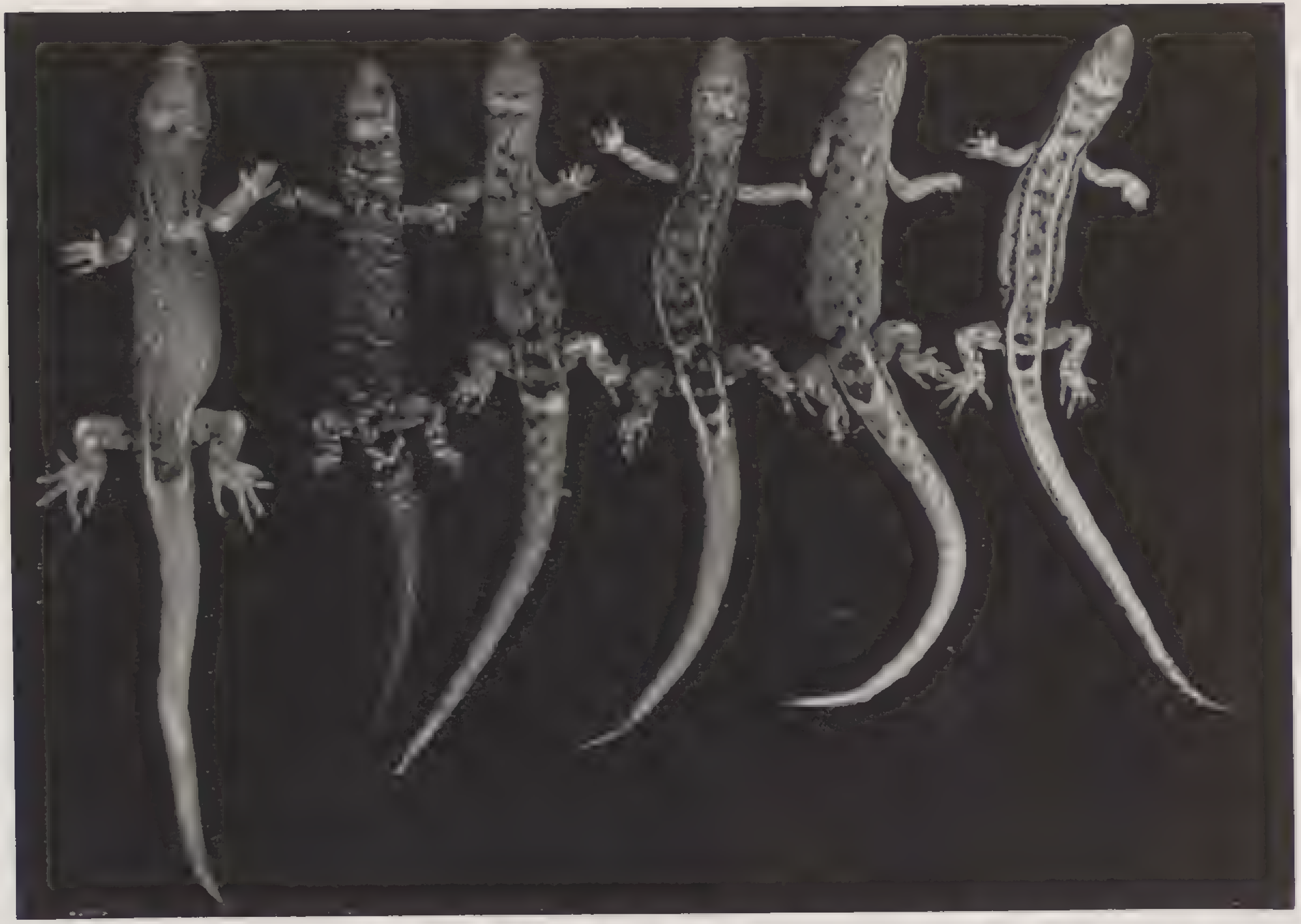

FIG. 2. *Lepidoblepharis xanthostigma* Noble (left to right). No. 1, KUMNH 34641; snout-vent length, 37 mm., tail, 41 mm., Isla Bonita, Heredia Prov. No. 2, 38937; snout-vent length, 34 mm., tail regenerated, Palmar, Puntarenas Prov. No. 3, 34626, snout-vent length, 32 mm., tail, 37 mm.; Bataan, Limón Prov. No. 4, 34653, snout-vent length, 31 mm., tail, 36 mm., Los Diamantes, Guápiles, Limón Prov. No. 5, 34651; snout-vent length 31 mm., tail, 39 mm., Los Diamantes, Guápiles, Limon Prov. No. 6, 34643, snout-vent length, 31.5 mm., tail, 39 mm.; Turrialba, Cartago Prov.

in color; about 23 scales across snout between the posterior edges of the first supralabials. Ear opening a third larger than an internasal scale.

On back the scales are small, elevated, juxtaposed, the granules growing a little larger and somewhat more conical on sides; these are abruptly differentiated from the large imbricating scales of the venter; granules on occiput scarcely half as large as those on dorsum; ventral scales in about 20 longitudinal rows; scales on posterior part of neck and breast similar in character to other ventral scales but somewhat smaller. Posteriorly on venter, scales are somewhat larger than elsewhere; dorsal and anterior part of upper arm, anterodorsal region and part of underside of forearm, front and ventral part of thigh, and underside of tibia with enlarged imbricating scales, while remaining parts generally are covered with small scales or granules.

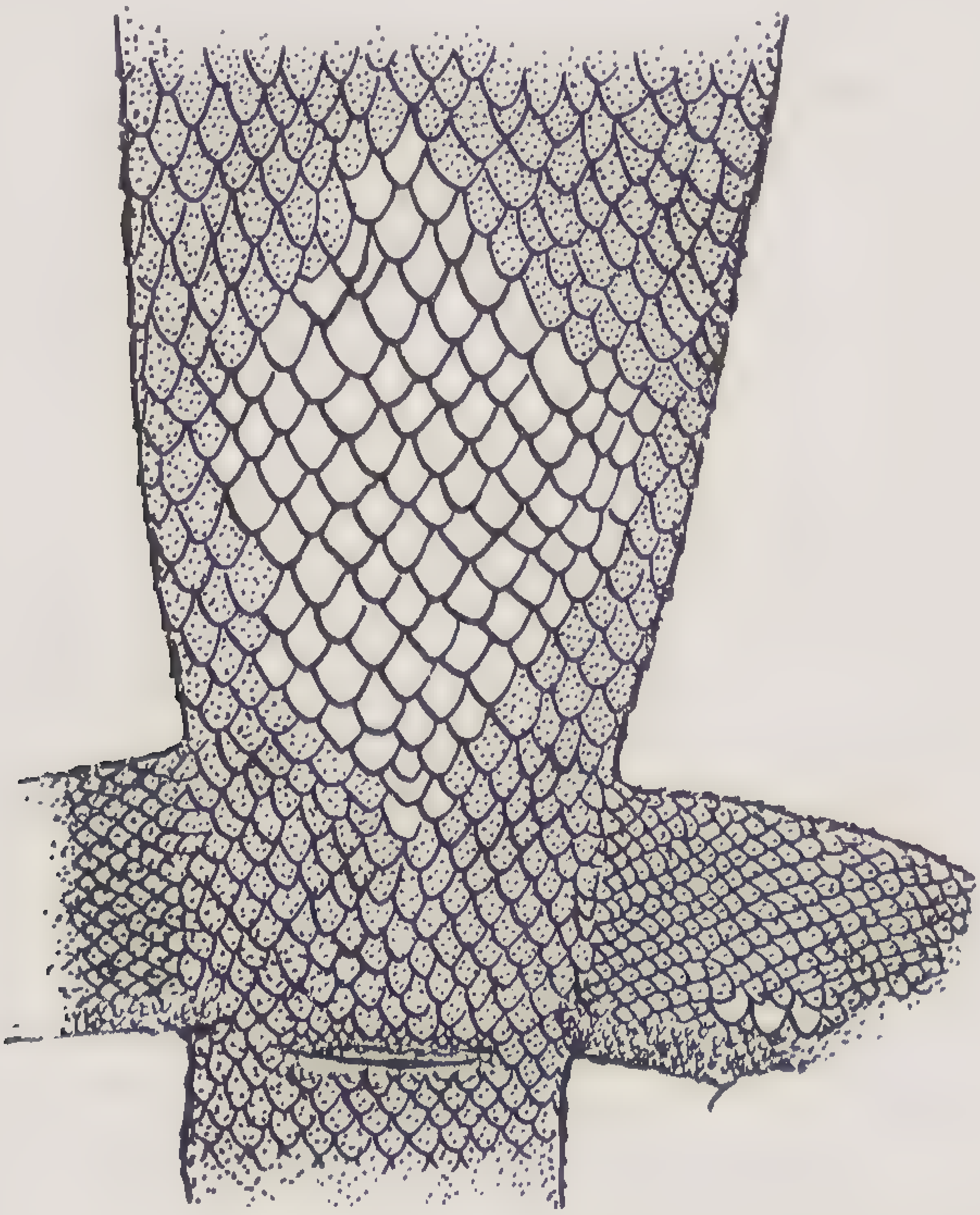

Fig. 3. *Lepidoblepharis xanthostigma* Noble. Pattern of escutcheon scales of venter and femora (scales without pigment); much enlarged.

Dorsal and lateral surfaces of tail covered with enlarged imbricating scales, more rounded than those on venter; on ventral surface, beginning somewhat behind the vent, a median series of about 50 enlarged subcaudals, the scales alternating larger and smaller; tail rounded in cross-section.

Digits of hand and foot with their distal part forming an angle with the basal part, all with claws vertically retractile into a sheath composed of six scales; under surface of digits with widened flat imbricating scales, one or two at base and terminal scales usually divided; scales on palm and sole small, flat, juxtaposed.

On posterior ventral surface an escutcheon consisting of a group of about 100 modified "glandular" scales, distinguished from adjoining scales by an almost complete absence of surface pigment except at extreme edges of individual scales, the pigment forming a slightly wider border where these scales adjoin the normal scales. On distal femoral area, three scales show a partially or completely similar modification; none are present in the postanal area.

Color in life: Above dark brownish lavender with very indistinct lighter areas; head somewhat less dark, with an indefinite light band partly divided mesially by a dark line, and bordered fore and aft by darker bands; top of head lighter than body, the snout and supralabials rather brownish; a very indefinite light line behind eye, bordered by darker color above and below; infralabials dark blackish brown with cream spots; chin and throat yellowish with brown dots, the lines or reticulations extending back to near breast; venter, except for glandular scales, nearly uniform light lavender; tail slightly lighter than body, dorsally and laterally with indefinite lighter markings; under surface lavender; glandular scales paper white; limbs similar to body in color, somewhat lighter beneath; back surface of thigh dark, enclosing dull cream spots.

Measurements in mm.: Snout to vent, 31; tail, 35.5; total length, 66.5; arm, 8.9; leg, 12.2; width of head, 4.8; length of head, 9.

Variation: The Costa Rican material available consists of 95 specimens, the following from the Caribbean drainage area: Limón Province: KUMNH Nos. 38926-38934, Limón; 38935, Mountain Cow Creek, near Limón; 34617-34631, Bataan; 34656, 34655, 38925, La Lola; 38000-38013, 38923-38924, Suretka; 34609-34614, 34645-34655, 34664, 38944-38947, Los Diamantes, Gúapiles. Heredia Province: Nos. 36272-36273, Puerto Viejo; 34661, Cariblanco; 34641-34642, Cinchona, 4,500 feet.

From the Pacific drainage area: Guanacaste Province: Nos.

38936, 34666-34668, Tenorio, Las Cañas; 36261-36371, Tilarán. Puntarenas Province: Nos. 34669, 38937-38943, Palmar; 34634, Golfito.

In the series of 95 specimens now in the collection there is considerable variation, concerned with sexual dimorphism, color pattern, scale characters, size, and age. A group of specimens from a locality may exhibit almost as much variation in certain characters as specimens from the Pacific lowlands differ from those in the Caribbean area. The group of specialized scales in the abdominal region of the male and on the distal part of the femur are wanting in the female, and the surface pigmentation of the scales is undifferentiated in the area.

The ventral scales of females are perhaps a little more rounded posteriorly, and since the skin may be distended a little more, the scales of the longitudinal rows seem actually larger having wider visible contact with the following and preceding scales. The number of enlarged ventral rows varies between 16 and 20, those from the Caribbean drainage having nearly the same average as those from the Pacific drainage. In snout-vent length the largest specimen measured 38 mm. This was from the northernmost point where the species was found in the Caribbean drainage. Specimens measuring 37 mm. were taken at Tenorio, the northernmost locality in the Pacific drainage, and at Cinchona, the point of highest elevation where specimens were found.

The specialized scales on the venter show decided variation in the number involved. Thus, in the escutcheon series from Limón specimens, I count from 60 to 110 "glandular" scales in adult and old specimens; but only 28 to 46 in a juvenile and a young adult. The differentiation of the scales, as to absence of surface pigment, begins posteriorly. It is probable that other scales are actually already differentiated, but these will not assume their typical appearance until later. Even in some of the older specimens, scales adjoining the differentiated scales may show areas in which no surface pigment is present. There usually are three modified glandular scales on the distal part of the femur but these may be indistinct or absent; on the other hand there may be two or three in a second row making a total of five or six of the specialized glandular scales.

The shape of the mental varies in that the median rim may be sharply truncate or may be irregular followed usually by three, sometimes two or very rarely as many as five scales. In some collections the median of the three scales is largest.

The spectacle and fringe are difficult to describe. However, they are continuous and closely applied about the eyeball.

The two large horizontal ciliary and subciliary scalerows bordering the shelflike expansion (one row above, the other below) vary and the posterior pointed scales may be blunt. One of the scales is usually nearly as wide as the shelflike expansion. The relative sizes of the labials do not remain completely constant in the series.

In two specimens the internasals are broadly in contact along the median line; in other specimens the scales are smaller and may be separated by a single large scale or by as many as three tiny ones. On the sides of the base of the tail there is a distinct shallow depression apparent in practically all of the specimens.

The scales on the tail are not arranged in transverse rows but rather in diagonal rows. Only two or three specimens of the 95 have a complete tail, the others being wholly or partially regenerated. The subcaudals are enlarged, a larger wider scale alternating with one somewhat smaller and narrower, the two together marking a caudal vertebra.

The character of the ear-opening in the preserved material is somewhat deceptive and may be represented by a line or may be oval or nearly circular at times.

The somewhat curved lighter band across the occiput is usually discernible. This may be bordered anteriorly and posteriorly by a narrow darker band, one of which may have a median dark process partially dividing the light band. The infralabials and mental bear large dark spots surrounded by cream or yellow color. The markings on the chin are usually present as spots or lines, the latter evident especially in the area below and somewhat posterior to eye. In nearly every group of specimens there is one or more that have distinct dorsolateral cream lines that originate behind the eyes and join together on the base of the tail, the junction usually preceded by a dark area. These are usually males, but not necessarily so. One specimen from Turrialba is light with dorsolateral lines and a clearly differentiated pattern of dark median transverse spots, about ten in number. The dorsolateral cream line is bordered below by a discrete dark line continuing on the tail as a broken line. The lighter sides have numerous dark specks while the chin and throat have a series of diagonal lines. The posterior surface of the thigh is cream with a black median stripe on one side and irregular spots on the other. The venter and subcaudal regions are flecked with darker.

Specimens from Palmar (a few meters above sea level) in southwestern Costa Rica have the occipital cream band more distinct and the sides of the body have a series of small ocellated cream spots running along the side of the body and tail.

It is not improbable, that with material from more northern and southern areas of the range of the species that it will be possible to differentiate subspecific populations.

Genus Gonatodes Fitzinger

Gonatodes Fitzinger, Systema Reptilium, 1843, pp. 18, 91 (type of genus, *Gymnodactylus albogularis* Duméril and Bibron).

Description of genus: Digits more or less cylindrical, the distal portion compressed forming an angle with more proximal parts; the lower surface of all digits with a single row of plates or scales; body slightly depressed, granular above; tail not compressed; pupil circular. Males without typical femoral or preanal pores, but with a large series of special glandular scales on posterior part of venter and sometimes on ventral surface of femora and behind vent on base of tail.

This genus formerly included numerous Asiatic and African species now recognized under the genus *Cnemaspis.* Seemingly there is but a single species represented in Costa Rica,—*Gonatodes fuscus* Hallowell. It occurs along the entire eastern coast, and perhaps also on the west coast. It was a common species at and near the port of Puntarenas. It has also been reported from Bebedero, Guanacaste Province. I have taken it at Liberia in the same province.

Gonatodes fuscus Hallowell

(Fig. 4)

Stenodactylus fuscus Hallowell, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 3, 1955, p. 33 (type locality, by restriction of Smith and Taylor, Rama, Nicaragua); Cope, Proc. Acad. Nat. Sci. Philadelphia, 1874, p. 68 (Nicaragua).

Gymnodactylus fuscus A. Duméril, Arch. Mus. vol. 8, 1856, p. 477; Bocourt, Mission Scientifique au Mexique et dans l'Amérique Centrale; Études sur les reptiles, livr. 2, 1873, pp. 48, 49, pl. 10, fig. 5 a-c.

Goniodactylus braconnieri O'Shaughnessy, Ann. Mag. Nat. Hist. ser. 4, vol. 16, 1875, p. 256 (*fide* Boulenger; type locality, Baranquilla, Colombia).

Gonatodes albogularis fuscus Boulenger, Catalogue of the lizards in the British Museum, 2nd Ed., vol. 1, 1885, pp. 59-60 (Colombia; Panamá); Wettstein, Sitzungsb. Akad. Wiss. Wien, Mathem.-natur. Kl. Abt. 1, Bd. 143, Heft, 1 and 2, 1934, p. 19 (Bebedero, Costa Rica).

Gonatodes albogularis Günther (*part.*) Biologia Centrali-Americana; Reptilia and Batrachia, Feb. 1890, p. 80 (Nicaragua and Panamá).

Gonatodes fuscus Stejneger, Proc. U. S. Nat. Mus., vol. 53, 1917, pp. 264-265; Parker, Ann. Mag. Nat. Hist., ser. 9, vol. 17, May 1926, p. 549 (Gorgona Island, Colombia); Gaige, Hartweg, and Stuart, Occ. Papers Mus. Zool.

Univ. Michigan, no. 357, 1937, p. 8 (Nicaraguan localities); H. Smith, Copeia, 1944, p. 187; Evans, Copeia, 1947, no. 3, Sept. 12, p. 168 (Corozal, Canal Zone). Smith and Taylor U. S. Nat. Mus. Bull. 199, 1950 pp. 45-46 (Chiapas, Mexico).

Diagnosis: Basal phalanges of digits cylindrical; strong sexual dimorphism, the males much darker than females. Snout obtusely pointed a little longer than the diameter of orbit. Gular region of male orange or yellowish. A median whitish line bifurcating on chin.

Description of species (From KUMNH No. 34577; Limón, Costa Rica): Head short, the snout length a little greater than the diameter of the orbit (skeletal), not or slightly greater than the greatest depth of the head in the occipital region; rostral scute large, the part visible above somewhat flattened medially, with a median suture (not reaching down to lip); nostril surrounded by rostral, first labial, supranasal, and (on the posterior rim) three postnasals; supranasals large, separated by a depression occupied by a single small scale anteriorly and two small scales posteriorly; six supralabials, first large, nearly twice area of second; second and third of nearly same size; fourth, fifth, and sixth diminishing in size, the suture between last two lying below the middle of pupil; posterior part of mouth bordered by eight scarcely differentiated scales; a spectacle, with an extrabrillar fringe surrounding eye, widest anteriorly; anterodorsally there is a ply or fold in the fringe; outer anterodorsal edge of fringe with a series of enlarged somewhat compressed conical scales and anteriorly these are preceded by other somewhat enlarged flattened scales.

Snout covered with tubercular or pyramidal scales, often somewhat compressed, larger than other dorsal scales; on back about 22 in a distance equal to that between middle of eye and nostril and 26 across snout between the second infralabials; mental very large, its labial border equal to that of rostral and four fifths of that of first labials; first infralabials separated by a distance about equal to width of one labial; two enlarged postmentals; each first infralabial bordered by three chin scales, one of which is the postmental; five differentiated infralabials, the first double the size of second; behind these, others, diminishing in size; angle of mouth bordered by about five small scales; two or three somewhat enlarged rows of scales on chin following postmentals; other scales on chin and throat granular, juxtaposed, the transition to the rounded imbricate scales of venter, abrupt. Scales on back, conical tubercles, slightly larger on sides; on tail, dorsal and lateral scales

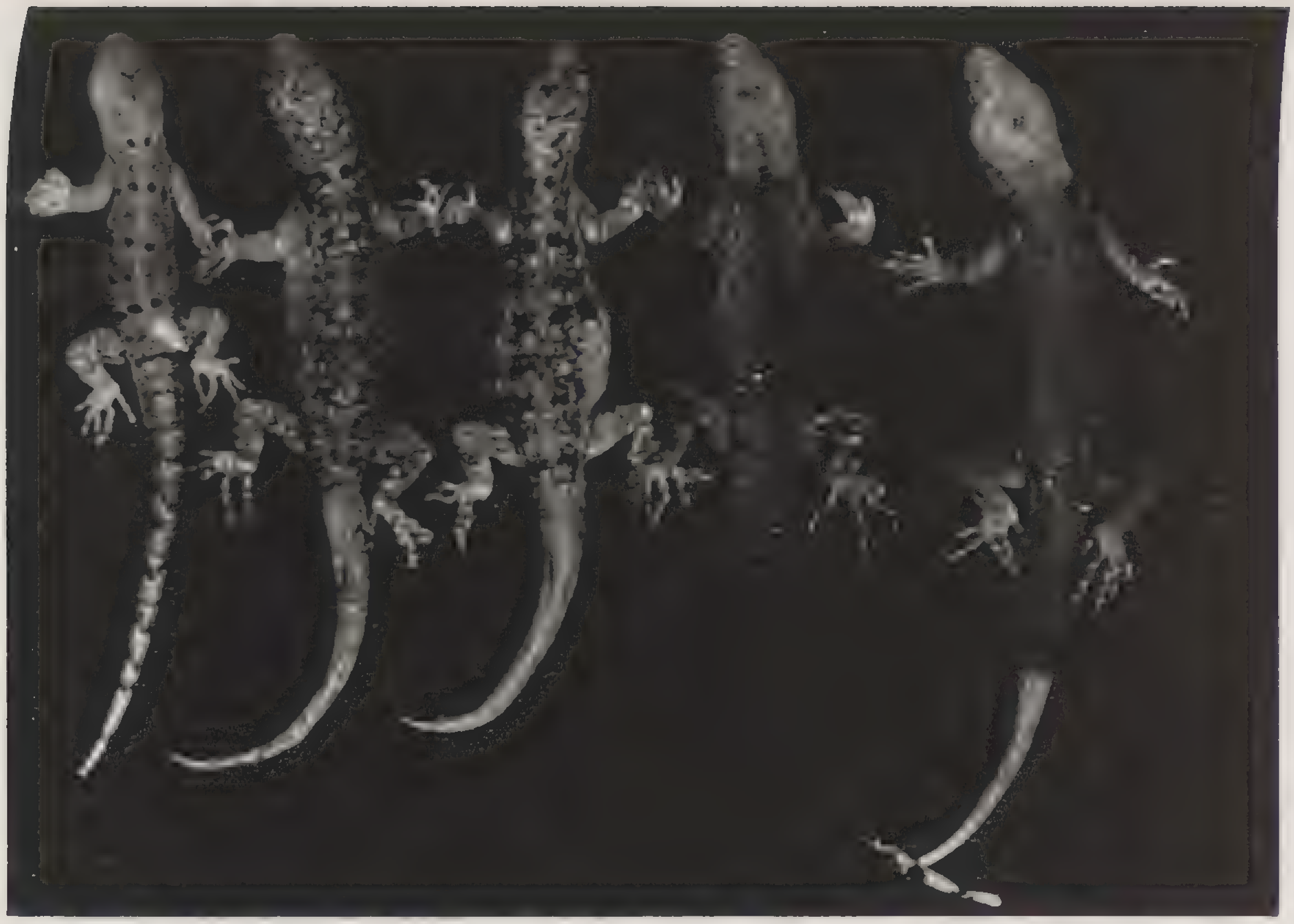

FIG. 4. *Gonatodes fuscus* Hallowell. From left to right, KUMNH No. 34565 ♀, Maribella Hotel, mouth of Río Barranca, Puntarenas Province; actual snout-to-vent measurement, 43 mm., tail, 40 mm.; 34608 ♀, La Lola, Limón Province; snout to vent, 33 mm., tail, 41 mm.; 34586 ♀, Limón, Limón Province; snout to vent, 42 mm.; 34580 ♂, Limón, Limón Province, snout to vent, 42.8 mm., tail 51 mm.; 34554 ♂, Maribella Hotel, Puntarenas Province.

flat, subimbricate, forming nearly straight transverse rows, smaller dorsally, growing larger on sides; the median subcaudal row about three times width of adjoining scales; the posterior two thirds of tail regenerated; in this part, dorsal scales are smaller than those on original part of tail, the rows not normally transverse, the median subcaudals shorter but considerably wider than original subcaudals; scales under thighs and tibia similar to ventral scales; on front of thigh a group of still larger scales.

Limbs well developed, the toes of adpressed limbs reaching to axilla; digits all with claws; basal part of toes slightly widened, covered with enlarged scales; distally digits somewhat compressed; under fourth toe eight larger basal scales and 15 scales on distal joints. On anterior face of upper arm and anterior face of forearm enlarged imbricating scales; on front of thigh and underside of tibia, scales likewise enlarged and imbricating; a slight axillary depression filled with minute, granular scales.

No typical femoral or preanal pores, but lying anterior to vent and extending forward more than one third length of the body, a group of about 200 specialized "glandular" escutcheon scales; on underside of each femur a group of about fifty similar scales arranged in five rows; on base of tail certain similar scales including one or two of the enlarged median subcaudals.

Color in life: Head generally orange brown to orange, with black spots below eye and mouth angle; body bluish black; tail on top and sides similar except tip which is dirty flesh-white. Under surface somewhat magenta. Chin and throat orange-red with a median yellow dividing line anteriorly, and with traces of darker and lighter olive-yellow parallel lines; belly blackish with the specialized escutcheon scales dirty flesh; sides of neck somewhat olive.

In preservative (formaldehyde and alcohol), head grayish brown, slightly lighter on snout and temporal regions; body and tail black with numerous grayish granules intermixed; chin and throat dirty white; underside of hands and feet light; specialized glandular scales light gray; tail black. A more or less discrete black area covering angle of mouth and the labial region below eye, extending to the second labials; digits dark, flecked with light.

Measurements in mm.: Snout to vent, 43.5; tail (reg.), 48.2; width of head, 8; length of head, 13.1; axilla to groin, 18.2; arm, 16; leg, 20.

Variation: The Costa Rican specimens in the collection are from the following localities: Puntarenas Province: KUMNH Nos. 34554-

34573, 37033, Maribella Hotel (mouth of Barranca River). Limón Province: Nos. 34574-34604 Limón; 34603-34606, Mountain Cow Creek; 34607-34608, La Lola. Guanacaste Province: two unnumbered specimens from Liberia. The species has been reported from Bebedero.

Sexual dimorphism in color is striking, the females differing in having the ground color gray or brownish gray. There are two dark spots on the rostral above, three spots on the frontal region, and a broken horseshoe-shaped dark mark beginning behind the eyes partly surrounding several indefinite dark marks on the occiput. There is a pair of dark spots on neck just in front of the shoulders and five transverse rows of indefinite dark spots on the body with an indefinite lateral row of rounded lighter spots. A pair of dark spots on the sacral region is followed on the dorsal surface of the tail by several indefinite dark spots sometimes with lighter cream centers. The sides of the body are darkly mottled in blackish and dull cream. The chin has a median light line, and there are some dim darker longitudinal lines that are lost on the neck. The mental is whitish. The median part of venter has an indefinite lighter line, and the underside is lighter than the sides of the tail. The labials are clouded with darker, the color usually partly surrounding the cream spots. The toes are banded with dark and light and the limbs have dark and light spots. In old females the dark color is more diffuse, the pattern as described is less distinct, the entire ventral surface is lighter, and the chin markings may be obsolete.

There is some variation in the exact number of the specialized "glandular" scales but specimens from both coasts show these in approximately the same number and arrangement save that there are usually some basal subcaudal scales obviously present in specimens taken along the western coast, that are usually if not always absent in eastern specimens.

Remarks: In Costa Rica the species is known in low areas especially near the seashore. It was very common in the port city of Limón. Many specimens were observed in the trees of the city park, in fact specimens could be observed in almost any sizeable tree in the city or its environs. Occasionally the gekkoes were seen about houses. Two newly-hatched young taken at Liberia, Guanacaste were found in the doorway of a hotel.

The females lay a single egg. One egg measured 7.1 x 6.15 mm.; the total length of an unhatched embryo was 33 mm.

Genus SPHAERODACTYLUS Wagler

Sphaerodactylus Wagler, Naturliches system der Amphibien mit vorangehender Classification der Saugetiere und Vogel, 1830, p. 143 (*Sphaerodactylus sputator* Cuvier, type of genus).

Description of genus: Digits narrow, slender, free, each with an asymetrical terminal lamella, the terminal portion transverse and in a different plane from the narrow proximal portion; scales under digits simple, transverse, usually undivided; all digits with claws retractile into a sheath on the proximal side of the terminal lamella; body scales may be granular, flat, or keeled, and either juxtaposed or imbricating. The "eyelid" is a spectacle with an extrabrillar fringe closely applied to eyeball and widened about upper anterior part of eye. No preanal or femoral pores, but in males a series of glandular scales on venter, anterior to vent, and in some species similar scales extending onto femoral region. Pupil usually, if not invariably round or very nearly so. A soft pointed spine is above the eye.

There are probably seven species of this genus in Costa Rica, including one on Cocos Island. It seems wise to recognize the following described forms: *Sphaerodactylus homolepis* Cope, *S. lineolatus* Lichtenstein and von Martens, *S. imbricatus* Andersson, *S. millepunctatus* Hallowell, *S. pacificus* Stejneger. Aside from the described forms there is evidence of the occurrence of another species in southwestern Costa Rica discussed elsewhere.

Sphaerodactylus glaucus Cope,* described from near Mérida, Yucatán, has been reported from near Sipurio as follows: "Variety with dark bordered interscapular and sacral transverse spots." It purports to be a specimen from the William Gabb Collection. The proper allocation of this specimen is in doubt. It is not impossible that a smooth-scaled form, still undescribed, inhabits southeastern Costa Rica. On the other hand it may be a young specimen of a described form. I await more material before I shall regard *S. glaucus* a member of the Costa Rican fauna. It would not be surprising, however, if it did occur since *lineolatus* occurs in the state of Veracruz, Mexico.

The genus occurs in the West Indies, southeastern Mexico, Central America, and northwestern South America.

The species are for the most part diminutive, and arboreal. Only a single egg is laid. This is placed in some relatively dry place under bark or debris, usually in company with the eggs of other individuals. So far as is known there is no voice mechanism in these gekkoes.

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* Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1876 (1875), p. 118.

The presence and distribution of glandular preanal and femoral scales, the so-called "escutcheon" * scales in the males of *Sphaerodactylus* offer very important characters in delineating species. These have been completely overlooked by many workers in this group.

KEY TO COSTA RICAN SPECIES OF SPHAERODACTYLUS

1. Subcaudal scales forming a single enlarged median series. Scales under regenerated tail much widened. Males with "escutcheon" scales of the preanal region continuous with the femoral series 2

Subcaudal scales not forming a single enlarged median series; scales of regenerated tail not strongly widened. Males with escutcheon scales forming a group in preanal ventral region, none on femora .. 3

2. Snout more elongate; a somewhat depressed area on median dorsal part of rostral; a crural spot outlined in cream often with cream area following; a white line on back of thigh bordered above by a brown stripe. In male, escutcheon scales are somewhat pigmented around edges, with two rows extending to near knee. Head of male reticulated in black, dotted below; dorsal scales imbricate, keeled. Female with five or seven narrow lines on head .... *lineolatus*

Snout shorter without depressed area on rostral. Scales on snout larger than in *lineolatus*, strongly keeled, as are scales on back. Escutcheon scales cream to bluish white without surface pigment, the femoral scales in three rows proximally, two distally; a dark and light band on back of thigh; male lacking heavy black reticulation on head and chin .... *millepunctatus*

3. Body and tail banded with darker, the young with smooth scales, adults with scales somewhat keeled .... *homolepis*

Body and tail not banded with darker 4

4. Head of males heavily striped or reticulated with black, similar area on chin and throat; females with obsolete head lines but with dim lineation on neck extending over shoulders, breaking up into indefinite rows of dots on body; no crural spot; back of thigh brown enclosing one or two cream spots; scales on body strongly imbricate and keeled. Smaller, 28 to 30 mm. snout to vent .... *imbricatus*

Males without heavy black lineation or reticulation on head. Generally light lavender, with darker lavender clouding tending to form bands on neck; preanal escutcheon scales 10-16; scales on dorsum ridged, juxtaposed, becoming somewhat flattened, imbricate and distinctly keeled on flanks. Larger species, 47 mm. snout to vent, *pacificus*

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* So named by Chapman Grant.

Sphaerodactylus pacificus Stejneger

(Figs. 5, 6)

Sphaerodactylus pacificus Stejneger, Proc. Biol. Soc. Washington, vol. 16, 1903, pp. 3-4 (type locality, Cocos Island, Pacific Ocean west of Costa Rica, Prof. Biolley, collector. USMN No. 31057); Barbour, Mem. Mus. Comp. Zool. Harvard College, vol. 47, no. 3, Dec. 1921, pp. 236-237, pl. 1, fig. 3, pl. 13, figs. 1-4.

Diagnosis: A rather large species of the genus (maximum size known, 47 mm. snout to vent); head and dorsal scales keeled, juxtaposed, small on middle of back, about 22 to 24 scales in a distance equal to that between tip of snout and center of eye,* smaller (about 36 in same distance) on occiput; about 12 on median part of venter; supranasals large, separated by two or three scales; snout somewhat wedge-shaped, flattened; mental truncate posteriorly, usually followed by two scales and these in turn by four; tail slightly longer than head and body; ear-opening not, or but rarely horizontal; a group of specialized glandular scales on venter in male anterior to vent (possibly subserving the function of preanal or femoral pores). A pointed scale on supraciliary border.

Description of the species (From KUMNH No. 38958): Head somewhat triangular, sloping strongly from interorbital region to tip of snout, leaving snout rather wedge-shaped; rostral large, the length of the part visible above, 1.2 mm., notched behind with a short median groove running forward nearly half length of scale; a pair of enlarged supranasals, separated by two small granular scales, with a third crowded into the rostral notch; four large supralabials anterior to the median point of eye, at which point the line of the mouth curves upwards abruptly, bordered by two small supralabials, making a total of six supralabials; nostril surrounded by rostral, supralabial, and a small "post nasal," the first labial being excluded from contact; ** movable part of "eyelid" nearly surrounds eye, the anterior and superior parts widest, covered with six to eight rows of granules; above the middle of eye a small erect spine on edge of the "lid" arising from the last of a series of larger scales; sixteen scales across snout between the second supralabials; frontal scales keeled, those on snout flat; mental with a larger labial border than rostral, truncate behind, bordered by three small scales; three infralabials to a point below middle of eye, the first longer than the two following; two very small posterior infralabials; ear-opening small, diagonal but not horizontal; scales on snout larger than other head scales; on occiput 35 granules in a distance equal to that from tip of snout to middle of eye. On dorsum near middle, 22-24 granular scales; on throat, 30 in same distance. Scales granular, juxtaposed with a keel visible on those of the sides and dorsum, the scales tending to form straight longitudinal rows; scales on venter much larger than those on back and sides, subcycloid, imbricate; on sides and dorsal parts of tail, fourteen straight transverse rows in standard distance; four or five rows of subcaudal scales

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* This "standard distance" used by Barbour *loc. cit.*, is useful as a basis of comparative measurement.

** This differs from the statements in other descriptions.

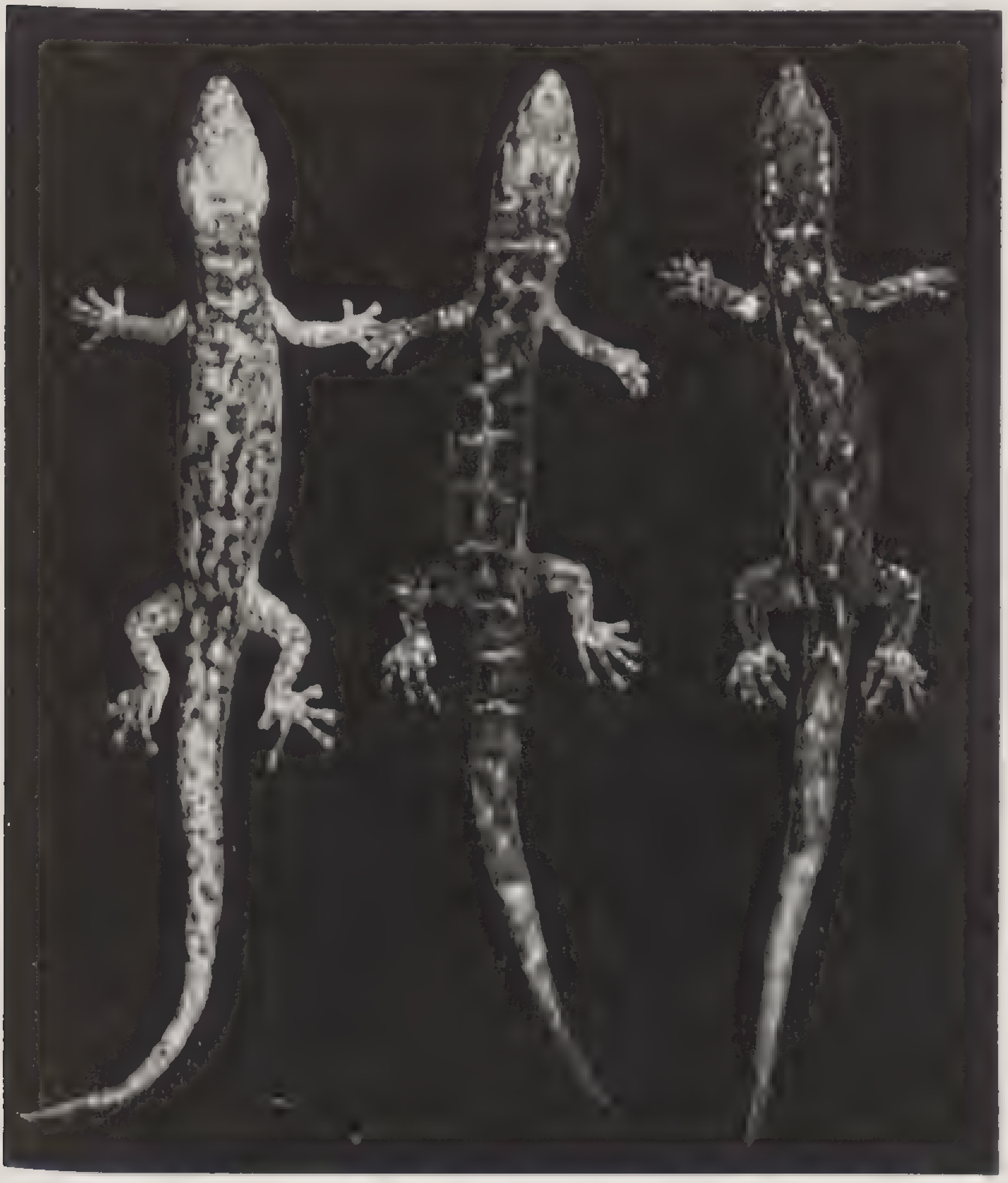

FIG. 5. *Sphaerodactylus pacificus* Stejneger. Inner figure, KUMNH No. 38958; actual length 128.5 mm. Middle figure, No. 38953; length, 121 mm. Outer figure, No. 38961; length, 129.5. All from Cocos Island, Pacific Ocean, west of Costa Rica.

are larger, irregular, not arranged in straight rows; two well-defined hemipenial swellings behind vent, with three slightly enlarged tubercular scales lateral to and somewhat in advance of the swellings; tail circular in cross-section; in advance of the vent a group of about 15 specialized "escutcheon" scales, lacking pigment; limbs overlap a distance equal to length of longest toe; digits terminating in an unsymmetrical flat digital disc, on inner side of which the retractile claw is directed inward; granules on upper posterior part of limbs smaller than those on the anterior faces; subdigital lamellae broad, flat, single, save for those immediately following the terminal lamella.

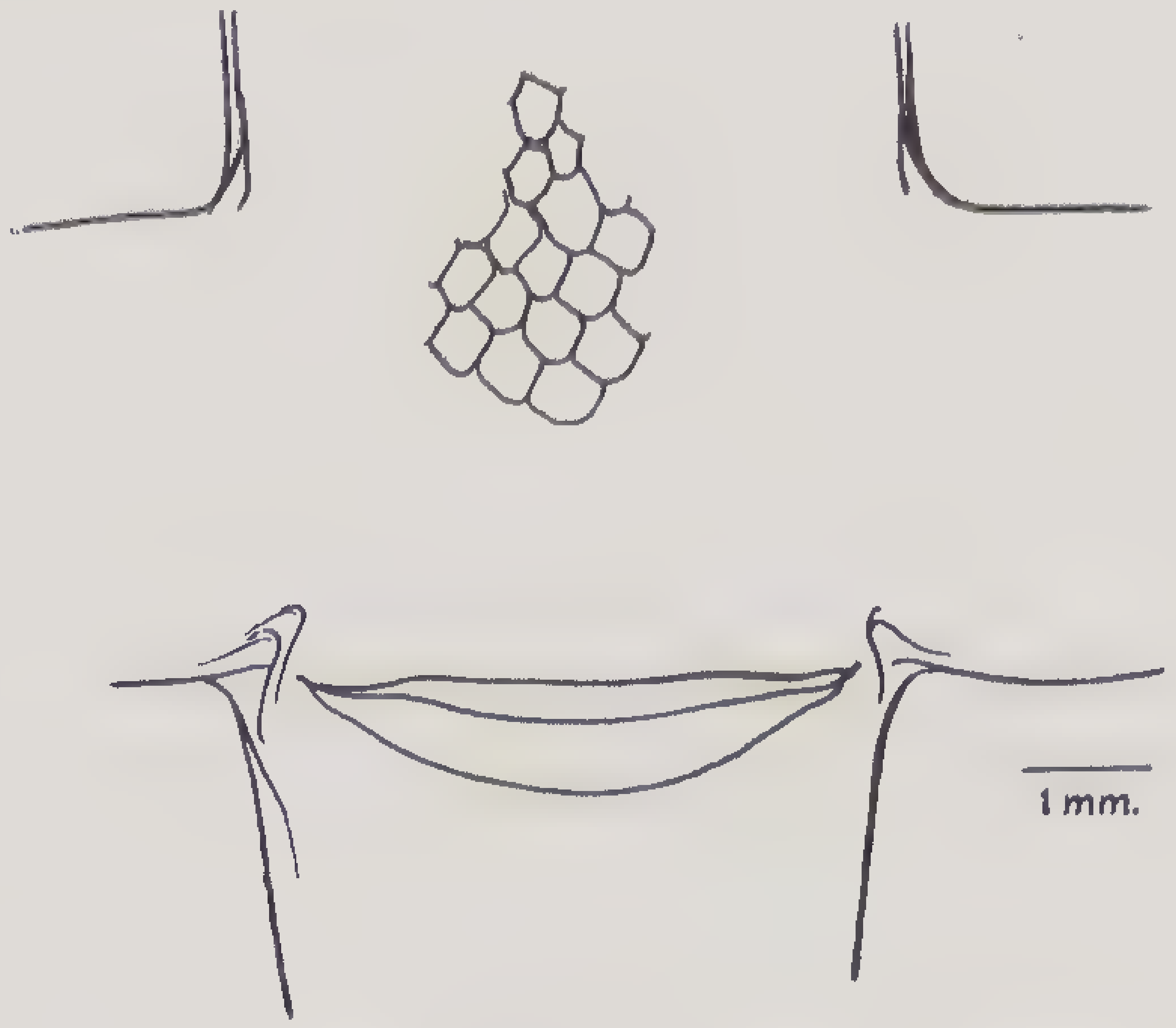

FIG. 6. *Sphaerodactylus pacificus* Stejneger. Escutcheon scale pattern. Cocos Island (topotype); much enlarged.

Color in life: Above generally light lavender with darker lavender clouding and markings tending to form narrow bands across neck; yellowish on venter and under tail.

Measurements in mm.: Snout to vent, 42.2; total length, 88; tail, 45.8; width of head, 7; head length, 12.2; snout to ear, 10.8; arm and hand, 12.2; leg and foot, 15.4; snout to eye, 4.6; diameter of eye, 2.

Variation: A series of 21 specimens (KUMNH Nos. 38953-38973) taken at the same time as the described specimen, vary considerably in the character of the dorsal markings. This is shown in the figures here given. In some of the specimens the lighter markings are frosted silvery flecks. Younger specimens are somewhat rose-colored under the tail.

Compared with the type description there are certain differences that are evident. Thus in my series the first labial is excluded from the nostril. The ear opening is varied and in none is the ear-opening horizontal. In some it is somewhat moon-shaped, in others the opening is nearly circular. From the type description it is obvious that the tail of the type is a reproduced one, since in the original tail the scales form very straight rows across the tail and are almost completely uniform in size except ventrally. Moreover, the ventral caudal scales although a little larger are not widened except where the tail is reproduced. Following the mental there are usually only two scales and these followed by four; behind these, the scales become smaller and merge into the minute granules of the throat. Specimens are noted with five supralabials to below center of eye and at least one has four infralabials on one side to the level of the middle of eye. The modified glandular scales on the median posterior part of the venter have a very thin loose epidermis underneath which is a flat cake of soft friable presumably noncellular material which may be loosened and removed with the touch of a needle; the bottom of the cuplike cavity shows a pigmented surface. The number of these scales in *pacificus* varies from ten to sixteen. They are contiguous but the group is not necessarily symmetrical.

Remarks: The gekkos were found for the most part close to the shore, under debris, and especially about the bases of coconut trees where the outer corky bark had grown over the surface of the aerial roots. They were captured when the bark was torn or chopped away. The eggs of this species were found hidden among these roots, usually several inches above the surface of the ground. Eight or ten empty shells might be in the same nook or live eggs might be mixed with the empty shells. In one place six live eggs were taken. Two of the females in the series are gravid each having only a single oviductal egg. It is presumed that this represents the normal clutch. Most of the females (but none of the males) have a goiterlike swelling on each side of the neck. An examination of preserved specimens shows, within the swelling, a sac filled with a calcareous deposit, connecting with the ear cavity. The deposit is pure white in color and of about the hardness of crayon. It is not or scarcely evident in the younger specimens. This goiterlike condition is also indicated in the figure given by Barbour (*loc. cit.* pl. 1, fig. 3).

Stejneger described this lizard from a small series of four specimens collected on Cocos Island by Prof. P. Biolly in 1902. A specimen of *Anolis townsendi* was also taken, a species described by

Stejneger in 1900 (Bull. Mus. Comp. Zool. Harvard Col., vol. 36, no. 6, Nov. 1900, pp. 163-64), and possibly the only other lizard on the island. I have examined the types in the U. S. National Museum.

Sphaerodactylus homolepis Cope

(Fig. 7)

Sphaerodactylus homolepis Cope, Proc. Amer. Philos. Soc. vol. 23, no. 122, Nov. 1886, p. 277 (type locality, Nicaragua; type USNM No. 14207); U. S. Nat. Mus. Bull. 32, 1887, p. 27; Boulenger, Catalogue of the lizards in the British Museum, 2nd ed. vol. 3, addenda, p. 491; Günther, Biologia Centrali-Americana, Reptilia and Batrachia, Apr. 1893, p. 82 (no specimens).

Sphaerodactylus homolepis carinatus Andersson, Medd. Göteborgs Mus. Zool. Afd. 9, 1916, p. 5 (type locality, Costa Rica. C. Bovallius coll.; Dunn, Herpetologica, vol. 1, no. 7, Jan. 29, 1940, p. 189-190).

Sphaerodactylus lineolatus (*part.*) Barbour, Mem. Mus. Comp. Zool., Harvard Col., vol. 47, no. 3, Dec., 1921, pp. 238-240, pl. 4, fig. 1.

Diagnosis: Young not keeled above; adults with dorsal scales keeled; subcaudals similar to dorsal caudal scales, *i. e.* not greatly enlarged on median row.

Head with seven longitudinal lines which may be distinct or obsolete. Four dark lighter-bordered cross-bands on body, one on nape, one on shoulder, one on middle of body, one in lumbar region. Tail with four dark bands separated by four lighter bands each more than double width of light bands.

Description of species: "Scales of upper surfaces small, flat, not granular nor keeled, a little smaller than those of the abdomen. Rostral plate large. Labials 5/4, first inferior labial corresponding to three superior labials. Muzzle a little longer than distance from eye to auricular meatus, and one and two-thirds times the length of the eye's diameter. Scales of lower surface of normal tail similar to those of upper surface.

"Brownish cream color with dark brown bands, longitudinal on the head, and transverse on neck, body and tail. There are seven lines on the head, one median, and three on each side. The inferior is short and is anterior to the auricular meatus; the second extends from the end of the muzzle through the eye to the neck, and the third runs backwards from the superciliary region to an equal length. The crossbands are not so wide as the spaces between them. One is at the nape, one crosses shoulders, one the middle of the body and one on the groin. There are four complete annuli on the tail.

"This species is of very small size. Total length m. .024; of head and body, .016; of head to auricular meatus, .004. No. 14207.

"This *Sphaerodactylus* is nearest the *S. sputator* of Cuba.

"In that species the scales are smaller, there are subcaudal scutella and the head bands are less numerous and distinct." Cope, 1886.

(The specimen one learns from the context is from Nicaragua sent by Dr. J. F. Bransford, U. S. N.)

Remarks: Cope described this species from a small juvenile specimen, reported as being 24 mm. in total length, the head and body 16 mm. The length of the tail is thus only one half that of the head and body, since it has banded color it must be presumed that it is a "normal," original tail. Barbour (*loc. cit.* pl. 4, fig. 1), figures a specimen of this species from Zent, Costa Rica which he regards as the young of *Sphaerodactylus lineolatus* Lichtenstein and von Martens. The markings in the figure and his description agree rather closely with Cope's original color description as far as can be ascer-

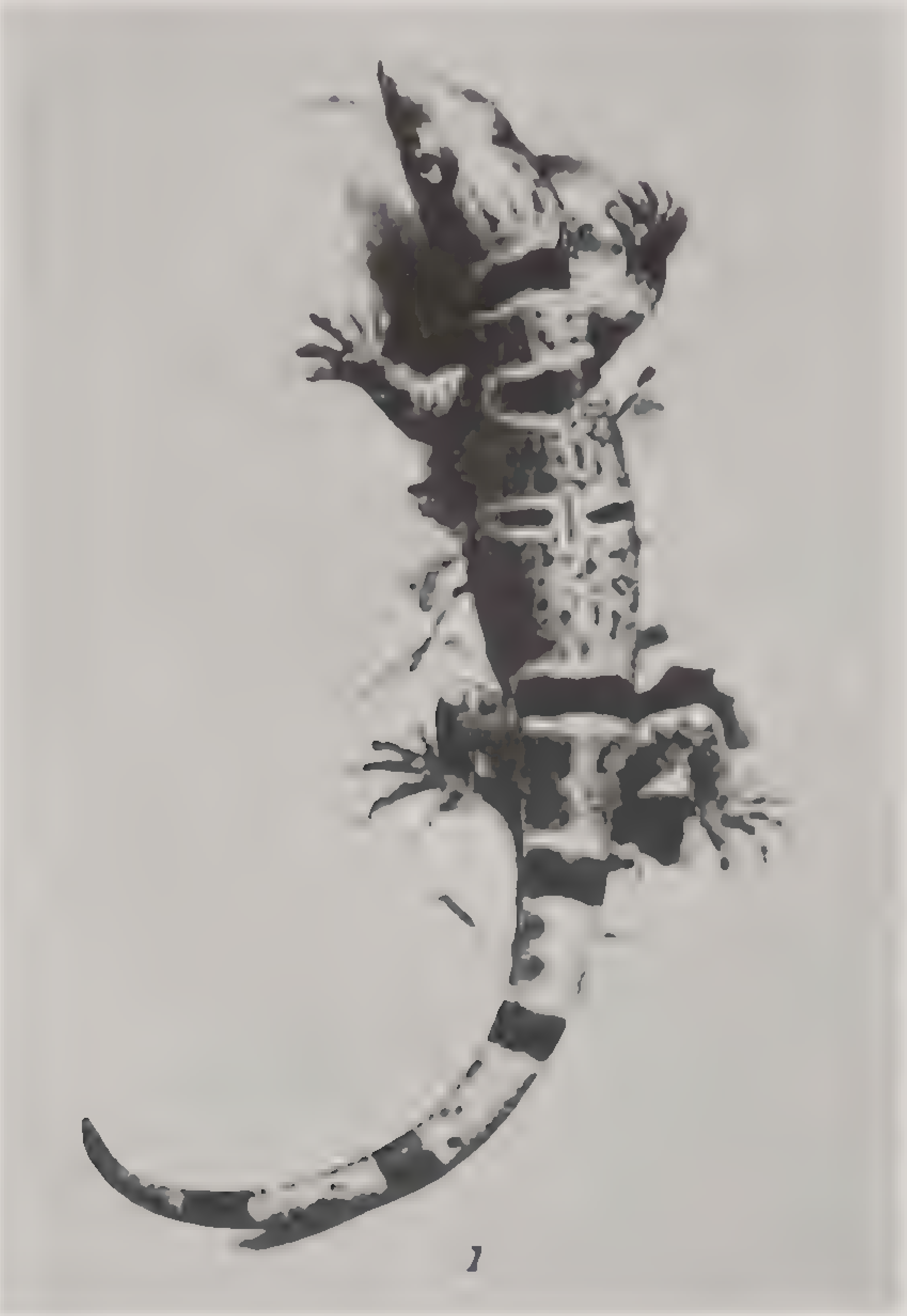

FIG. 7. *Sphaerodactylus homolepis* Cope. Figure from Barbour, "Sphaerodactylus," pl. 4, fig. 1.

tained. In this the tail is shown to be nearly as long as head and body.

Andersson reports a specimen, described as *Sphaerodactylus homolepis carinatus nov. var.* that is a large adult specimen 53 mm. in length of which the head-body length is 26, the tail 27. Thus it appears that the banded pattern is not merely a juvenile coloration but a characteristic of the species. Barbour has regarded it presumably as a juvenile character.

A specimen that I believe to have been of this species, also an adult, was seen at Los Diamantes, Gúapiles, Limón Province, Costa Rica. It was on the buttress of a large tree amply protected from a collector by wasps from several very active nests. The specimen escaped into a nest of large ants under wasp protection.

The chief differences between Andersson's *carinatus* specimen and the type are the presence of distinctly keeled scales, and a longer tail, both of which might be accounted for by the juvenile character of the type, since in certain other species the younger specimens having a relatively shorter tail than adults; and if keeled, the keels may be indistinct or even seemingly absent in the very young. The general similarity of color pattern also lends weight to their being the same form.

Sphaerodactylus lineolatus Lichtenstein and von Martens

(Figs. 8, 9)

Sphaerodactylus * *lineolatus* Lichtenstein and von Martens, Nomenclator Reptilium et Amphibiorum Musei Zoologici Berolinensis, Berlin, 1856, p. 6 (type locality, Veragoa = Veragua, Panamá); Bocourt, Mission Scientifique au Mexique et dans l'Amérique Centrale; Études sur les Reptiles, livr. 2, 1873, pp. 46-47 (a description of a type specimen loaned by W. Peters); Boulenger, Catalogue of the lizards in the British Mus. 2nd ed. vol. 1, 1885 pp. 221-222 (*part.*) (two varieties listed one from an unknown locality, the other based on two specimens, one from Santa Cruz and one from Chontales, Nicaragua); Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Apr. 1893, p. 82 (*part.*) (reported from Mexico, Nicaragua, British Honduras, Panamá and Guiana); Barbour, Mem. Mus. Comp. Zool., Harvard Col., vol. 47, no. 3, Dec. 1921, pp. 238-240 (*part.*) (lower Central America, Guatemala, Nicaragua, Costa Rica, Panamá; Noble and Klingel, Amer. Mus. Novitates, no. 549, Aug. 11, 1932, p. 14; Gaige, Hartweg, Stuart, Occ. Papers Mus. Zool., Univ. Michigan, no. 357, 1937, p. 8 (Nicaraguan localities); Dunn, Herpetologica, vol. 1, 1940, pp. 189-190 (*part.*)).

Diagnosis: A median row of enlarged subcaudals; dorsal scales small, equal, lightly carinated; brownish fawn with five or seven dim longitudinal dark lines on head all disappearing on anterior part of body, except median, which does not pass beyond occiput; pectoral and abdominal scales cycloid or somewhat diamond-shaped.

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* Spelled *Sphaeriodactylus*.

Description of species: The original type description of this species is very brief. It follows:

"*Squamis dorsi aequalibus, granularibus. Rufescens, capiti supra linia mediana et utrinque tribus lateralibus nigricantibus ornato, dorso fusco-vermiculato. Long. a rostro ad caud. bas 1¼", caud. 1¼".*)"

Fortunately one of the cotype specimens was later redescribed by Bocourt (*loc. cit.*) so that little doubt remains as to the application of the name. I designate this specimen described by Bocourt as the type (lectotype) of the species.

Bocourt's description (rough translation) reads:

Upper part of the body brownish fawn with five very distinct longitudinal lines which arise on the head passing over the neck, and disappearing on the anterior part of the trunk. Scales of the back small, equal, lightly carinated, those of the venter larger, smooth, thin, and imbricated. Pupil rounded, claws relatively long.

This small species resembles *Sphaerodactylus fantasticus* Cuvier somewhat in the general form of the head, the rostral and mental scales, the labials and the ear-opening. Nevertheless it may be distinguished by the following characters: scales on the muzzle larger than those covering the temporal and occipital regions; on the neck, the back and the superior parts of the limbs they are small, of equal size and lightly carinated; under the neck they are granular; pectoral and abdominal scales much larger, diamond-shaped, smooth, thin, and imbricated. Tail mutilated, circular at its beginning, and probably of moderate length; above covered with imbricating scales arranged transversely; below there is a longitudinal series of large scales of nearly equal diameter and hexagonal form. Digits slender, their inferior surfaces bearing transverse scales, and having at their extremities a small smooth lamella, circular, and bearing a relatively large claw placed on the proximal edge of the lamella.

Length from snout to vent, 26 mm.

The upper parts of the body are brownish gray; five longitudinal lines of a darker color arise on the head. The shortest one is mesial on top of head and does not pass beyond occiput; the other two pairs begin one above the other below the eye and disappear at the beginning of the sides. Lower surfaces pale yellowish, the throat finely punctate with brown forming small linear designs slightly undulating. It is to the courtesy of Prof. Peters that the Paris Museum is acquainted with this small saurian, which comes from Veragua, Central America.

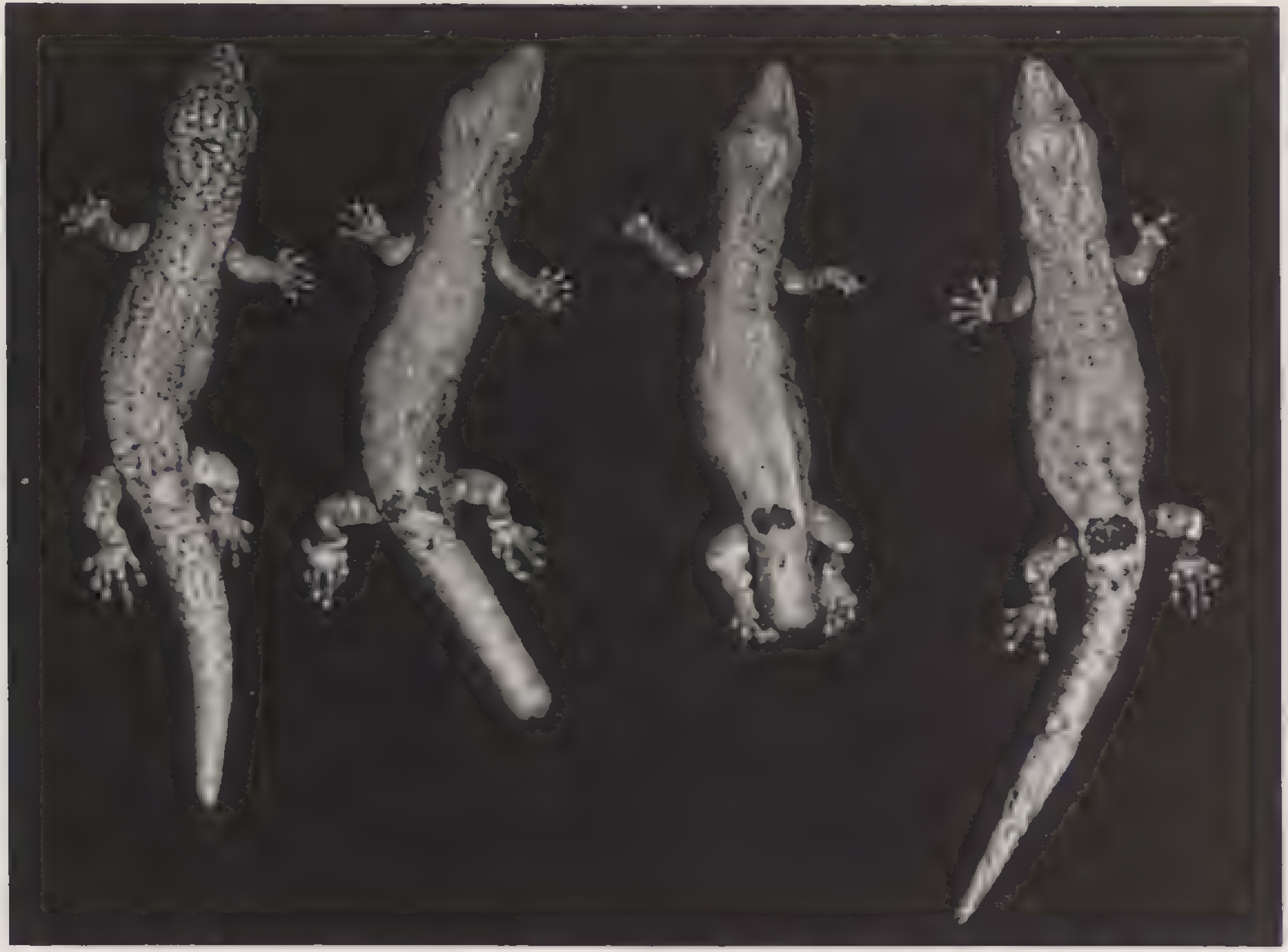

FIG. 8. *Sphaerodactylus lineolatus* Lichtenstein and von Martens. KUMNH No. 40504, actual length snout to vent, 27 mm., total, 45 mm., 40502, snout to vent, 30 mm.; 36123, snout to vent, 28.5, 40503, snout to vent, 30; tail, 53. All from Tenorio, Las Cañas, Guanacaste, except 36123, from Tilaran, Guanacaste.

Specimens of *lineolatus* agreeing so far as can be ascertained with Bocourt's description are in the collection. These are KUMNH Nos. 40501-04 from Tenorio, Las Cañas, Guanacaste, Costa Rica. The specimens from Tenorio were found on the buttresses of a large forest tree ensconced in growing plants. The general color was a light tan, approaching fawn color, with narrow blackish lines on the head, extending back to body. The chin and venter were bright yellow, or in one case cream-white on chin and venter. The under side of the tail was pinkish. The toes are banded indefinitely in dark and light. There is dark brown or blackish crural mark which may be bordered with cream or there may be a cream area preceding and following this mark.

The head markings are very narrow black lines arranged as follows: a black line from nostril to eye; a median line from back level of eyes to occiput; two lines from eye, the upper running back and tending to curve inward somewhat while the other runs straight back towards shoulder, the area between them showing a dimly distinct lighter line. Two other lines beginning at lower part of eye, the upper passing above the auricular opening, the other below it. A rather distinct white line bordering the darker dorsal color laterally has an indefinite darker border below it. There is a sharply defined white stripe on the back of the thigh that is continuous with a whitish bar across the lower dorsal part of the tibia. Above this line on the thigh is a transverse dark-brown stripe. There is a cream dark-edged spot on the knee, and a small ocellated spot above the thigh near the body. The arm has a cream mark on the elbow and one on the forearm.

A male specimen, 40505, taken at Tenorio is also referred to this species. The color, different from that of the females, is as follows: above tan (nearly fawn) with minute blackish or blackish brown dots, slightly larger and somewhat elongate on the basal part of the tail; the head is black, the reticulations enclosing cream spots and areas and tending to form three black and three cream lines posterior to eye. Most of the black markings terminate shortly behind occiput. The rostral, mental, and labials are cream, with distinct black spots, the chin and throat cream being strongly punctate with black. The venter is whitish with a fine scattering of brownish pigment. The glandular scales (figured) have a narrow border of brownish pigment. There is no black spot on the sacrum. The arms and legs have faintly distinct cream spots bordered by a darker color and a cream line on back of thigh. The underside of the tail is pinkish with some brownish pigment. There are some indistinct light bands on the digits. In preservative the cream has become white and the pink shade has disappeared.

In all these specimens (except those with regenerated tails) there is a strongly defined median series of subcaudals. The alternate scales are slightly smaller than the scales which precede them.

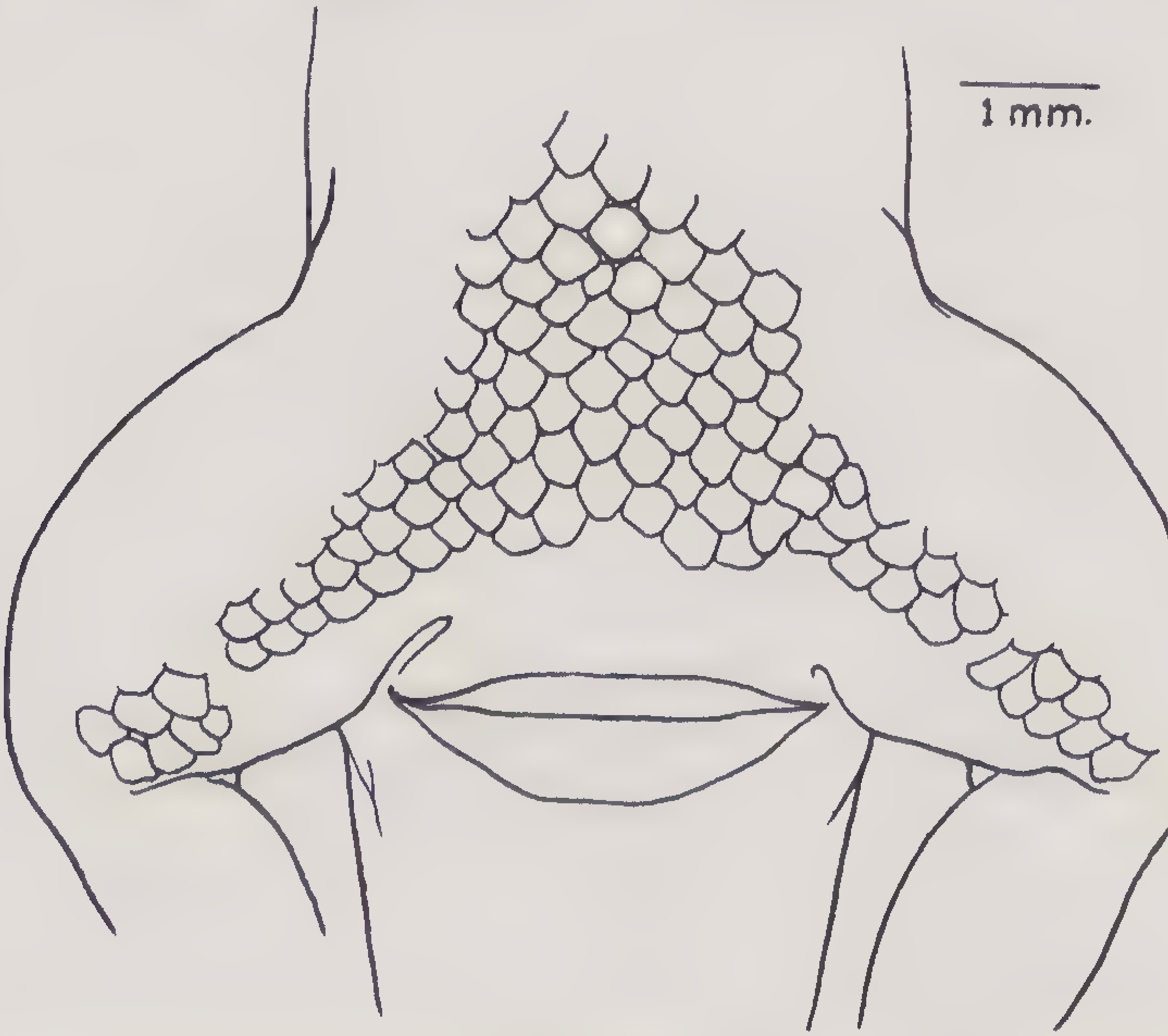

FIG. 9. *Sphaerodactylus lineolatus* Andersson. KUMNH No. 40506; Tenorio, Las Cañas, Guanacaste. Pattern of escutcheon scales, much enlarged.

The snout is rather long and there is a flattened depressed area on the part of the rostral scale exposed above. The scales are rather large on the back and sides, there being 42-44 strongly keeled scale-rows. The rows of cycloid scales on venter vary between 19 and 22 thus making a total of approximately 65 scales around the middle of body.

Measurements of Sphaerodactylus lineolatus

Number	36123 ♀	40501 ♀	40502 ♀	40503 ♀	40505 ♂
Locality	Tilaran	Tenorio	Tenorio	Tenorio	Tenorio
Snout to vent	28.2	30.2	29.2	29	26.5
Tail	....	....	12.8*	22.5*	18.5*
Length of head	8	9	8.5	8.6	8
Width of head	4.9	5.3	5.1	5.2	6
Snout to arm	11	11.6	11.3	11.1	11
Axilla to groin	13.2	15.2	14.5	14.6	12.2
Arm	7	7.3	7.2	7.3	7
Leg	8.7	9.2	9	8.8	8.3
Snout to eye	3.7	4	4	4	3.7

* Incomplete.

Remarks: Barbour's treatment of *lineolatus* probably involves more than one species. He specifically mentions enlarged subcaudals in the specimen he describes from Saboga Island, Panamá Bay, but examination shows that they are not in a single median line in the specimen. The only data in the literature regarding the glandular preanal and femoral scales is a statement by Noble and Klingel (1932). They do not give the source of their *lineolatus* and it may or may not be that of Lichtenstein and von Martens. They state that *S. lineolatus* has a band of hypertrophied scales on the thigh, closely resembling *S. cinereus*. The latter is described as having the median group [of hypertrophied "escutcheon" scales] small, and a narrow band of thickened scales extending down the ventral surface of the thigh for its entire length. The band is three scales wide at the proximal end of the thigh and two scales wide at the distal end.

Sphaerodactylus imbricatus Andersson

(Figs. 10, 11)

Sphaerodactylus lineolatus imbricatus Andersson, Med. Göteborgs Mus. Zool. Afd. 9, 1916, p. 5 (type locality Costa Rica, C. Bovallius collector).
Sphaerodactylus lineolatus (*part.*) Dunn, Herpetologica, vol. 1, no. 7, 1940, pp. 189-190.

This species originally described from Costa Rica (presumably from the eastern lowland) was synonymized with *S. lineolatus* by Dunn who states that this form, together with several other named species or subspecies (*S. homolepis carinatus* Andersson, *S. homolepis* Cope, *S. argus* Meerwarth [*non Gosse*] and possibly *S. millepunctatus* Hallowell), and "all other Sphaerodactylus material I have seen from Panama, Costa Rica, and Nicaragua" are conspecific with *lineolatus*.

Diagnosis: Scales about body in 70-73 rows, about 20 of which are smooth, cycloid, ventral; escutcheon scales confined to preanal region, none appearing on femora; strong sexual dimorphism; small species probably not exceeding 30 mm. snout to vent; dorsal scales flat, strongly imbricate, keeled.

Description of species (From KUMNH No. 40506, Bataan, Limón Prov., Costa Rica): Snout much narrowed at tip; rostral large, without a depressed flattened dorsal area, notched posteriorly and with a forward-directed median suture or groove, the most posterior part of the median dorsal portion of the scale not reaching front level of nostril; a pair of large supranasals bordering rostral, separated anteriorly by a single tiny scale, in the middle by two, and posteriorly by four scales; nostril surrounded by rostral, supranasal, first labial, while only a single small scale borders the posterior rim; six supralabials, the first a little smaller than second, the series then diminishing in size posteriorly, the last, minute, lying behind level of median part of pupil; behind this, mouth bordered by five or six small granular scales; scales on snout somewhat enlarged, flattened, keeled, about 19 between posterior borders of third labials; "eyelid" continuous, surrounding eye, widest above and in front of anterior half of orbit; this part bordered by a row of somewhat larger keeled scales, the posterior developed into a soft pointed spine; below these, on under surface of lid is a row of larger scales, lacking me-

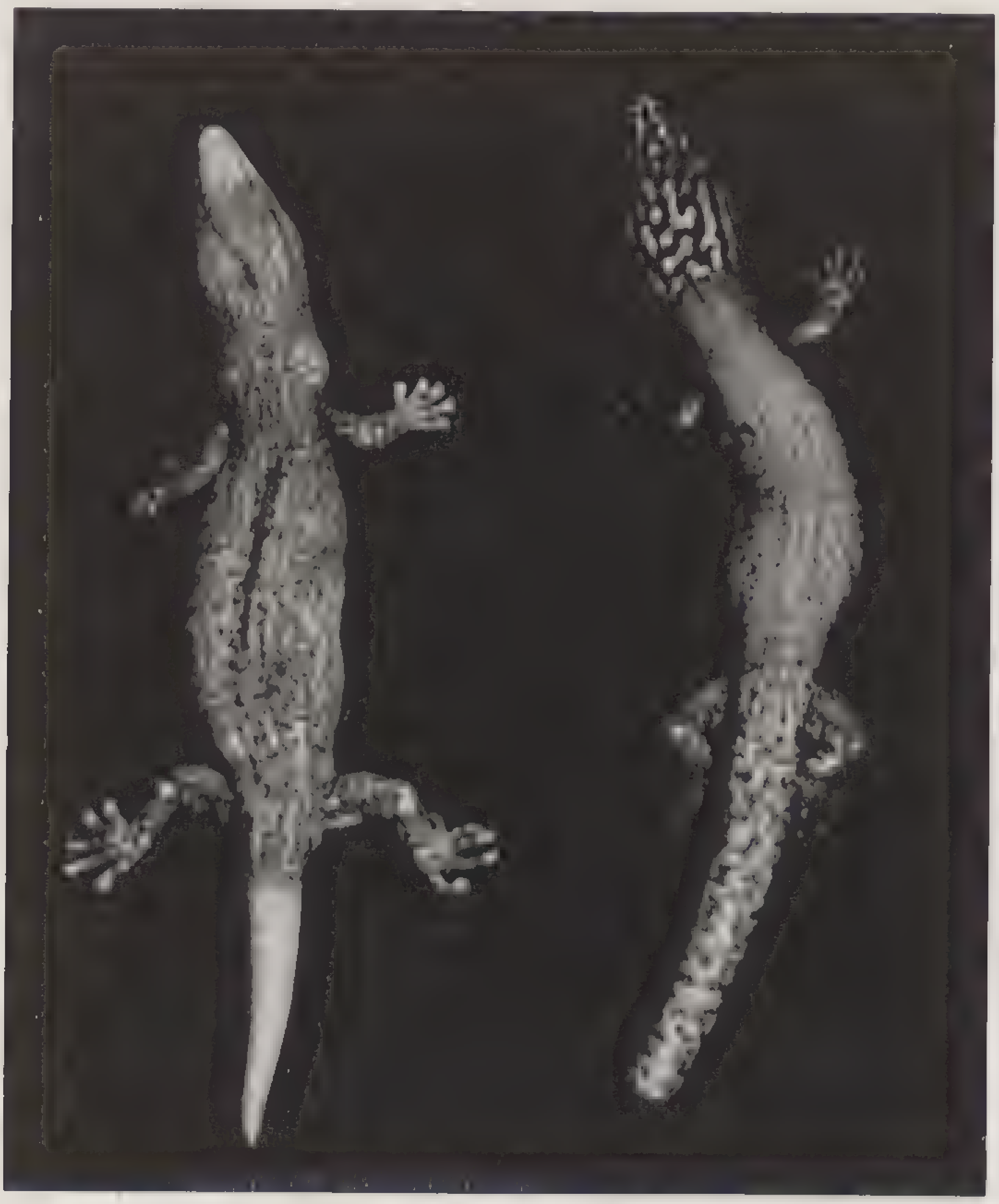

FIG. 10. *Sphaerodactylus imbricatus* Andersson. Left figure, KUMNH No. 40507 ♀; actual length snout to vent, 31.2, total, 45.1 mm.; right figure, 40506 ♂; snout to vent, 28.8, total length, 46 mm. Bataan, Limón Province, C. R. Female has calcium deposits on side of neck.

dian keels; pupil circular. Four infralabials, the first very large, equal to three and a half supralabials; fourth lies below sixth supralabial and is of about same size; mental with a larger labial border than rostral, its posterior part reaching back mesially beyond level of the mental-infralabial suture, and bordered by three somewhat enlarged chin scales. On chin and throat small juxtaposed somewhat cycloid granules continued to narrowest point of neck, at which point the scales abruptly become larger, cycloid and definitely imbricating and continue back over breast and venter to anus, interorbital scales keeled, a little larger, and more elongate than keeled scales on occiput; dorsal scales ridged, juxtaposed, those on sides and flanks becoming a little larger and somewhat imbricate. Scales on the tail forming transverse rows but the segments are not clearly marked; on under surface of tail the scales of several rows are larger than lateral and dorsal scales but there is no median enlarged series present; the ventral scales laterally pass gradually into the smaller laterals so that an exact count of dorsals and ventrals is difficult, but there are approximately 53 dorsal and 20 ventral rows around widest part of body. The specialized glandular "escutcheon" scales in the preanal part of venter number 60; none are present in the femoral region.

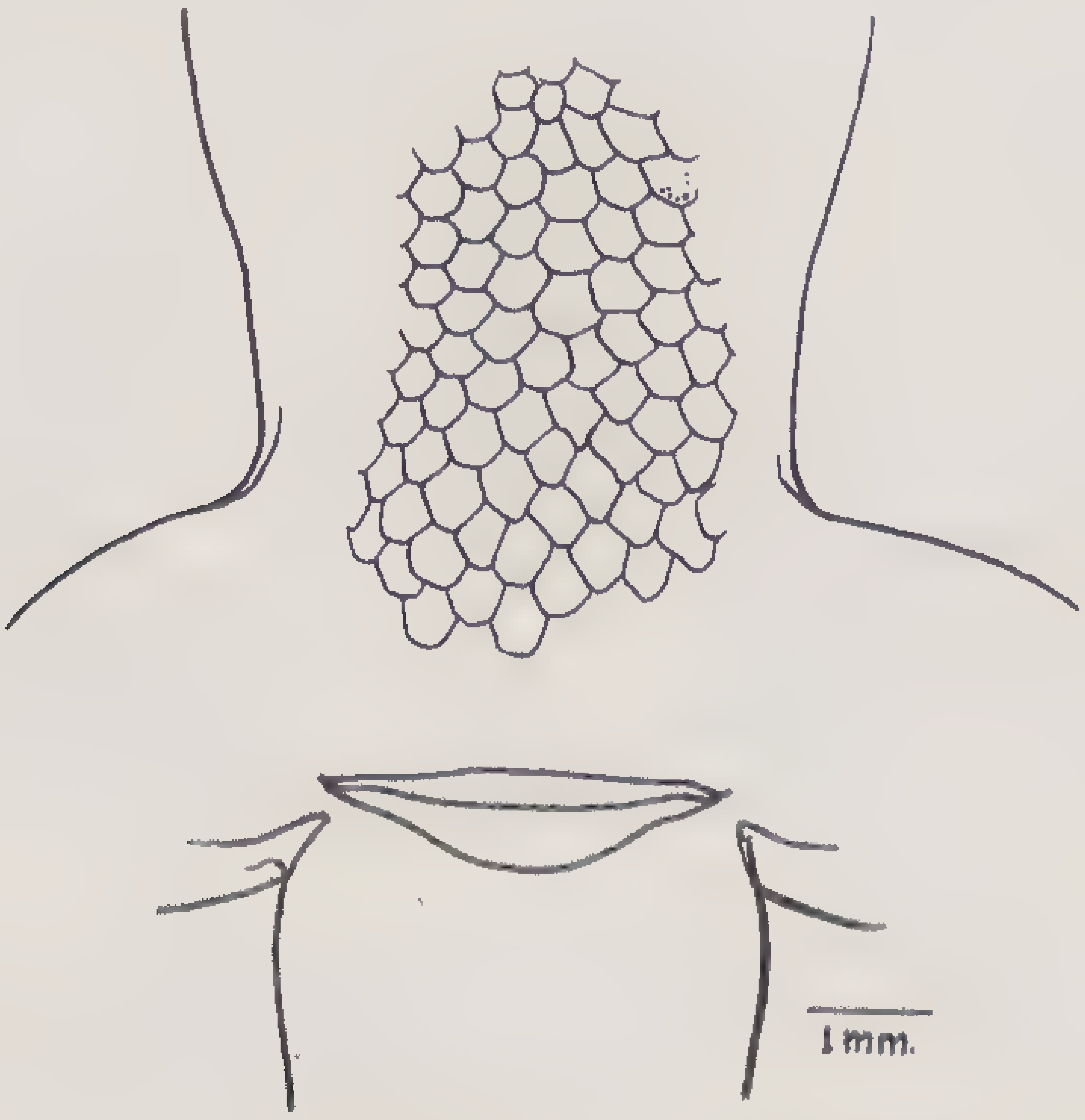

FIG. 11. *Sphaerodactylus imbricatus* Andersson. KUMNH No. 40506. Escutcheon scales on venter (much enlarged).

Scales on dorsal and anterior part of upper arm and forearm larger, imbricating, other scales smaller, juxtaposed, granular; legs, except back face of femur, with larger cycloid imbricating scales. Digits asymmetrical terminating in an enlarged lamella, irregular in shape, the distal, somewhat oval portion lies transversely and is in a slightly different plane from the posterior narrower portion; claws are retractile into a sheath lying along the inner (proximal) edge of lamella; subdigital scales transverse, single (rarely one or more divided), eleven or twelve under longest toe. No postanal sac or bones.

Color: Entire head and extreme anterior part of neck black and cream-white arranged in more or less irregular black and white longitudinal stripes on sides of head; one black line beginning on rostral continues behind eye; the median lines are irregular and somewhat reticulate; labials with black spotting; chin and throat heavily reticulated in black and cream-white, the color extending back to the narrow point of neck, where it ends abruptly; remainder of neck and body nearly uniform brownish with a few indefinite brownish flecks on sides and posterior part of dorsum, each fleck not exceeding size of a scale; venter light brown, somewhat yellowish in life. Tail lighter tan on dorsum and sides with brownish flecks larger than those on body; under side of tail whitish; a few whitish dark-bordered spots on leg and foot; back face of thigh with one or two indefinite light areas. There is no evidence of darker lines on neck and shoulders.

Measurements in mm.: Snout to vent, 28.8; total length (part of tail missing), 46; axilla to groin, 11; length of head to ear, 7.1; width of head, 5; arm, 7.3; leg, 9; snout to center of eye, 4; center of eye to ear, 3.3.

Variation: Three female specimens referred to this species are KUMNH No. 40507 from Bataan, Limón Province and 40508-40509 from Lake Bonilla, Tunnel Camp, Peralta, Cartago Province. These lack the heavy black marking and reticulation on the head, as well as the glandular preanal scales.

The scalerows around the widest part of the body are from 72 to 74 of which 20 or 22 are ventral, cycloid, smooth, and imbricate. The subcaudal series agrees with that of the described male, as does the keeling and general characters of body squamation.

The color markings are different. The head is a little lighter than body, and beginning at the nape there is a series of six or eight very dim nuchal darker-brown lines extending onto shoulders then breaking up into very numerous smaller brown flecks over the body.

There is a light darker-edged spot on back of thigh, one at the ankle and knee, and one or two light flecks on the dorsal surface of the thigh. The arm is indefinitely reticulated with brown, enclosing a slightly lighter area. On the head there is a canthal line and two indefinite darker lines behind the eye.

In the Lake Bonilla specimens the nuchal lineation is more pronounced, and the dark flecking on the body is more in evidence.

Remarks: The described specimen was captured on a tree at Bataan. Andersson (1916) mentions having three specimens. The type presumably is designated by No. Re. ex. 1326. However, the description is something of a composite and should the number represent a lot number I propose that one of the specimens with the black and white head be designated the type. It is, of course, not impossible that two forms are represented in Andersson's material.

Sphaerodactylus millepunctatus Hallowell

(Figs. 12, 13)

Sphaerodactylus millepunctatus Hallowell, Proc. Acad. Nat. Sci. Philadelphia, Oct. 1860, pp. 480-486 (type locality, Nicaragua *fide* Cope. Hallowell states, "abdominal scales carinated." Cope [P. A. N. S. P. 1861, p. 499] regards Dr. Hallowell's statement concerning carinated scales as being incorrect); Cope, Proc. Acad. Nat. Sci. Philadelphia, Dec. 1861, pp. 494-500 (Nicaragua); Troschel, *in* von Müller, Reisen in den Vereinigten Staaten, Canada und Mexico, vol. 3, p. 599; Bocourt, Mission Scientifique au Mexique et dans l'Amérique Centrale; Études sur les reptiles, livr. 2, 1873, pp. 45-46 (no specimens).

The discovery of a specimen of *Sphaerodactylus* at Tenorio, Las Cañas, Guanacaste, Costa Rica, 70 km. south of the Nicaraguan border, that differs from *lineolatus* and seems to agree with the published characters of *millepunctatus,* leads me to believe that previous authors who have placed this form in the synonymy of S. *lineolatus* may have done so in error. The type description of the species is very brief:

Special characters: "Dorsal scales very small, unicarinate; color reddish with numerous small brownish spots; under parts white; length of head and body, 11 lines.

Description: "Scales upon muzzle larger than those upon the vertex; those upon body remarkable for their small size, . . . Abdominal scales carinated, much larger than those upon throat and chin; color reddish-brown above, with numerous brown spots, intermingled with very minute white points; under parts white. Two specimens."

Cope (1861, *loc. cit.*) adds some pertinent data, stating that the occipital scales are granular, the frontal scales keeled, the muzzle short and the auricular orifice smaller than the digital expansion; the color is light brown with a postaxillary, a loreal, a median occipital, and two postocular brown lines. A brown, transverse, crural spot, bordered posteriorly with white. From Nicaragua.

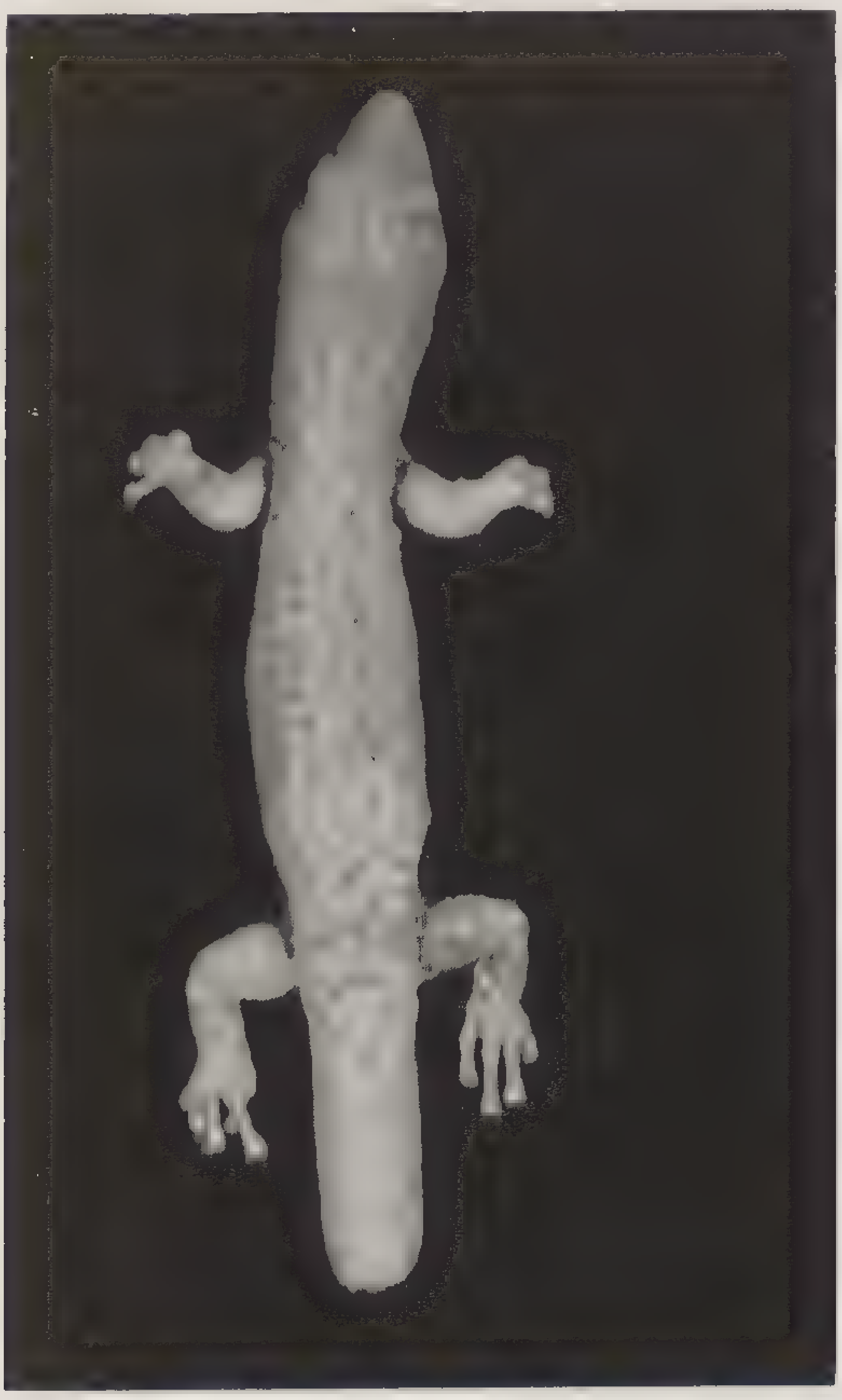

FIG. 12. *Sphaerodactylus millepuntatus* Hallowell. KUMNH No. 40504♂; Tenorio, Las Cañas, Guanacaste, C. R.; actual total length of figure, 35.4.

Diagnosis: A small species, the scales strongly keeled on frontal and dorsal body regions; reddish or grayish brown above with numerous small darker spots; white below; muzzle short; a brown crural spot; in males a large group of glandular scales on posterior part of venter continuous with two series extending onto thighs; strongly enlarged series of subcaudals, each alternate scale a little smaller than preceding.

Description of species (From KUMNH No. 40504, Tenorio, Las Cañas, Guanacaste, Costa Rica): Snout short with a relatively small rostral scale having a small entrant suture posteriorly; dorsal part of rostral without a small depressed posterior portion; a pair of internasals separated by a single scale anteriorly, by two posteriorly; nostril surrounded by rostral, supranasal, first labial, while the posterior rim is bordered by two small scales, the larger upper one of which appears to be segmented from internasal; scales on snout juxtaposed, much larger than those on occiput, each with smooth surface but bearing a clearly defined keel; about 17 scales in a transverse row across snout between the second labials; five supralabials, four to a point below pupil, the first largest, the series diminishing in size posteriorly. Mental larger than rostral, with a larger labial border and with two postmentals touching it posteriorly; five infralabials, the first larger in area than the four succeeding labials; posterior part of mouth bordered above and below by minute granules. Scales following postmentals somewhat enlarged, juxtaposed, gradually becoming smaller to narrowest point of neck then rather quickly transforming to cycloid imbricate smooth scales which continue on venter to vent; on sides the transition to the ventral body scales is rather gradual, about 22 longitudinal ventral rows can be distinguished at middle of body; scales on neck tubercular, juxtaposed; dorsal and lateral body scales imbricate, distinctly keeled; ventrals smooth. Large imbricate scales on dorsal and front face of upper arm, on part of dorsal and front face of forearm; remainder covered with smaller granular scales; legs with large imbricate keeled scales save on posterior dorsal and posterior parts of femur and upper surfaces of tibia which are covered with smaller scales or granules; toes with smooth transverse lamella, irregular, the outer part asymmetrically transverse and in a different plane from the proximal portion, which is differently colored from the distal part.

On the posterior part of the venter and on the ventral surface of the thighs there is a symmetrical group of specialized glandular scales, whitish in color, and almost without surface pigment. The scales total approximately 91. The ventral (preanal) group consists of about 30 scales from the posterior borders of which are extended outward three linear series of scales, two of which reach the extremity of the femoral region. On the right femur there are 29, on the left 32 scales.

A series of greatly enlarged, transversely widened, somewhat hexagonal, subcaudal scales (the posterior part of tail missing) each alternate scale a little larger than one following; on tail the transverse rows of lateral and dorsal scales not clearly marked; however, a diagonal arrangement is clearly defined; a row of scales bordering subcaudal series somewhat enlarged; dorsal scales on base of tail distinctly keeled; ear-opening moderate, somewhat vertical, smaller than a terminal digital lamella.

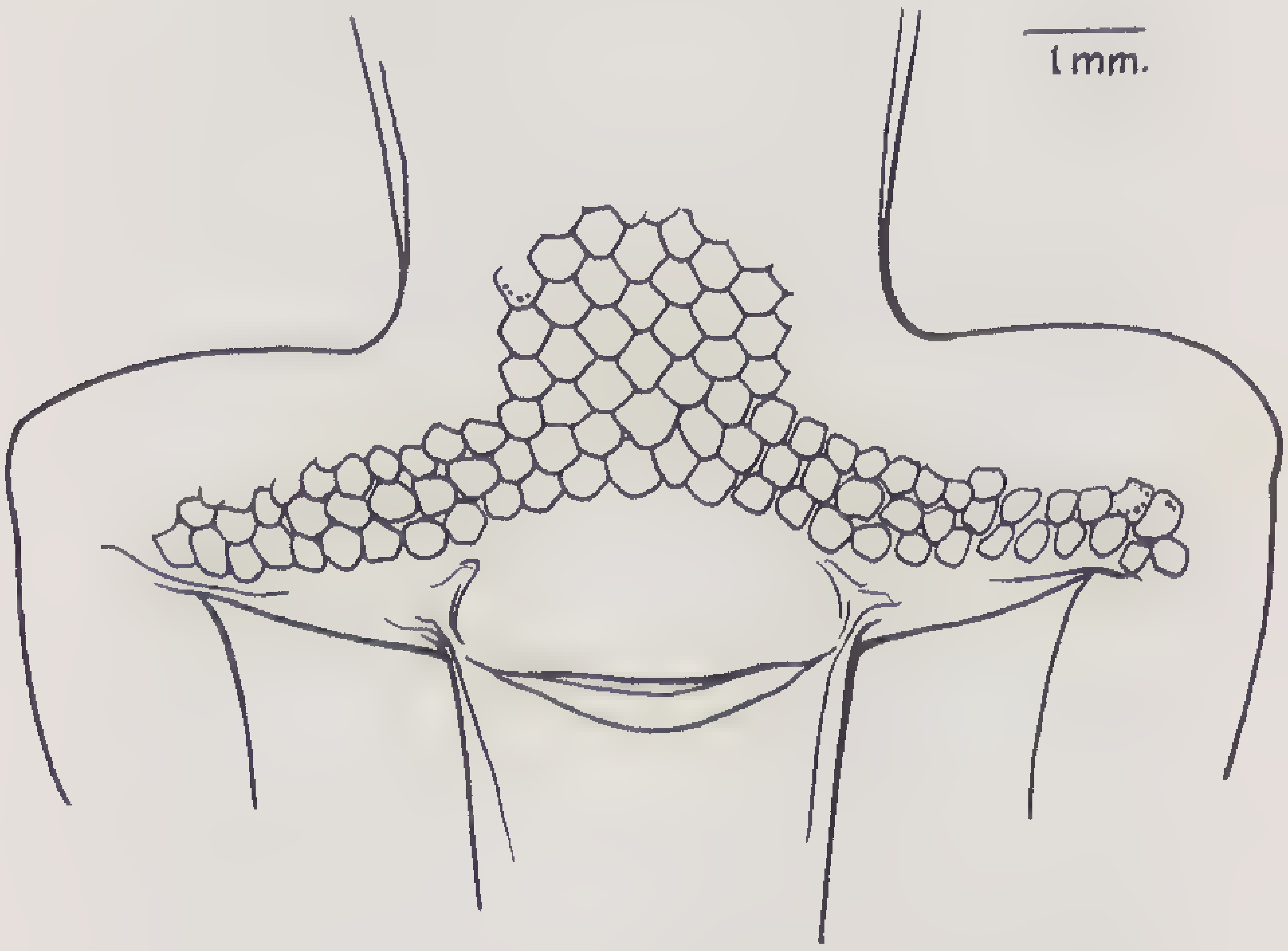

Fig. 13. *Sphaerodactylus millepunctatus* Hallowell. KU MNH No. 40504. Escutcheon scales (much enlarged). Tenorio, Las Cañas, Guanacaste, C. R.

Color: The dorsal coloration generally is reddish to gray brown above, the head only slightly lighter than dorsum; a short median line barely discernible on occiput. A diagonal line from eye across occiput intersects one from opposite side on middle of neck; second line from eye parallels the first, the area between a little lighter than elsewhere. Body with very numerous dark spots covering two to four scales, the spots more or less arranged in rows; a barely distinguishable crural spot with a somewhat lighter area behind it; the tail with a dim but more or less regular pattern; pink under tail; chin and belly dirty white, pigment scattered equally on scales, but each scale somewhat darker on borders. No pigment on surface of the glandular scales of the escutcheon; line of demarcation between dorsal and ventral coloration not strongly marked. An indistinct transverse cream line on back of thigh continuous with cream mark on ankle; light spot just below knee.

Measurements in mm.: Snout to vent, 27.2; tail (broken), 8.2; snout to middle of eye, 3.8; head length, 7.3; snout to arm insertion, 10.25; axilla to groin, 11.8; arm, 6.8; leg, 8.7.

Remarks: This specimen taken in the same general area with what I regard as typical *Sphaerodactylus lineolatus* seemingly differs from them in having a distinctly shorter head, shorter rostral without a flattened portion; a scale divided from internasal back of nostril; larger strongly keeled frontal scales; diagonal or chevron-shaped arrangement of the dorsal and lateral caudal scales; absence of a marked delimitation of dorsal color by a light line from axilla to groin; the terminal lamella of the digits proportionally larger than in specimens of *lineolatus.* The male does not have a specialized color of black and cream.

Whether this specimen is referable to Hallowell's *millepunctatus* may be questioned. Boulenger placed *millepunctatus* in the synonymy of S. *lineolatus.* Barbour disregarded the name entirely. It would appear that no reviser, except possibly Cope, has seen the type specimen. Cope in his review of the genus (1861) gives data on Nicaraguan specimens presumably the types and corrects Hallowell's statement that the ventrals are keeled. He recognized it as a distinct species but at the same time was seemingly unfamiliar with S. *lineolatus* of Lichtenstein and von Martens.

Unless the type can be re-examined and more detailed data made available as to the character of the subcaudals, the number of scale rows about body and the character of the "excutcheon" scales the status of *millepunctatus* and of the described specimen will remain obscure.

Sphaerodactylus sp?

A specimen of a small sphaerodactyl captured by John Baker, at Palmar, Puntarenas Province, Sept. 2, 1952, either escaped from a faulty collecting bag or was eaten by a small *Leptodeira* taken at the same time. Only the tail of the gekko remained when the bag reached camp.

I believe that the tail belongs to a species of *Sphaerodactylus* that differs from the recognized forms at hand in being banded with six lavender brown bands separated by five, distinctly narrower cream bands. On the under side of the tail the dark bands are of a somewhat lighter shade. A row of 38 enlarged, somewhat hexagonal scales are present on the medial ventral surface, each alternate scale a little smaller than its predecessor. The adjoining lateral scales are somewhat enlarged. The lateral and dorsal caudal scales are small, imbricating, unkeeled, and rather unequal in size. They form straight transverse rows, four to each vertebra. There are, seemingly, 19 vertebrae as indicated by faintly distinct lines.

FAMILY GEKKONIDAE Gray

Underwood's recent redefinition of this family is as follows:

"Spectacle covering eye; vertebrae amphicoelous; clavicles perforated or secondarily imperforated; three or four pairs of sternal ribs; digits with or without pilose pads; no fovea; male commonly with preanal and/or femoral pores and postanal sacs and bones."

He separates the family into two subfamilies as follows:

A. Pupil vertical with straight margins. Diplodactylinae

B. Gekko-type pupil or secondarily circular. Gekkoninae

The subdivision into subfamilies is as yet based on rather meagre characters, but subsequent study may strengthen their status.

One of the extraordinary facts which has not been pointed out previously is that none of the Gekkonidae endemic in the Western Hemisphere have developed preanal or femoral pores. They are known to occur only in the imported genera, *Hemidactylus* and *Peropus*. The two cosmopolitan genera with endemic species *Tarentola* and *Phyllodactylus*, are without femoral or preanal pores throughout their range in the Western Hemisphere so far is is known. Presumed endemic forms of *Hemidactylus* should be reexamined. Underwood has shown that *Gymnodactylus, sensu stictu* is a South American genus without pores and that Old World forms formerly regarded as *Gymnodactylus* belong in one or more different genera.

Genus THECADACTYLUS Cuvier

Thecadactylus Cuvier, Règne Animal, vol. 2, p. 48 (type of the genus *Gekko laevis* = *rapicauda*, by monotypy).

Description of genus: Digits half webbed; tail subcylindrical with imbricate scales; digits with two series of lamella divided by a groove; claws present on all digits, retractile into a groove in a terminal sheath (sometimes absent on inner digit). Body covered with juxtaposed scales, those on venter imbricate; no femoral or preanal pores, and likewise lacking specialized glandular scales on venter and femora; pupil vertical; "eyelid" incomplete, not entirely surrounding eye.

Only a single species is recognized in the genus. This is a widespread form, occurring from Yucatán in Mexico to northern South America. It is also found in the West Indies.

Thecadactylus rapicaudus (Houttuyn)

(Fig. 14)

Gekko rapicauda Houttuyn, Verh. Zeeuwsch. Genootsch. Wet. Vlissingen, vol. 9, 1782, p. 323, pl. 3, fig. 1 (type locality, American Islands, restricted by Smith and Taylor to Chichén Itzá, Yucatán).

Gekko laevis Daudin, Histoire naturelle des reptiles, vol. 4, p. 112-114 (type locality, "Amérique Meridionale").

Gekko Surinamensis Daudin, *idem,* vol. 4, pp. 126-129 (type locality, Surinam).

Lacerta rapicauda Gmelin, Systema Naturae, vol. 1, p. 1068.

Thecadactylus laevis Gray, Ann. Philos, ser. 2, vol. 10, p. 198; Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1876 (1875), p. 119 (Costa Rica "Mouth of Estrella or north River, East Coast").

Thecadactylus rapicaudus Gray, Catalogue of the specimens of lizards in the collections of the British Museum, 1845, p. 146; Boulenger, Catalogue of the lizards in the British Museum, vol. 1, 1885, pp. 111-112; Günther, Biologia Centrali-Americana; Reptilia and Batrachia, April, 1893, p. 81; Smith and Taylor, U. S. Nat. Mus. Bull. 199, 1950, p. 49 (restriction of type locality).

Platydactylus theconyx Duméril and Bibron, Erpetologie Générale, vol. 3, 1836, p. 306, pl. 33, fig. 2.

Description of species (From KUMNH No. 34112): Head rather triangular, very distinct from neck. Rostral enlarged, its width nearly two and one-half times its length, bordered behind by a pair of large internasals that are wider than long, and form a common median suture; nostril lying posterior to suture between rostral and first labial, surrounded by rostral, internasal, and first labial, its posterior rim bordered by four small scales; scales on snout only slightly larger than those on back, about fifty in a line across snout between the third labials; eyeball nearly as large as orbit; spectacle covering eye, the fringe incomplete, extending across top of eye and half way down in front of eye, and for a short distance behind posterior edge of eye; latter portion beset with a series of eight or nine enlarged spinelike scales; scales on anterior part of fringe somewhat enlarged, but not spinelike; a small fold on anterodorsal part; 12-12 supralabials, behind which there are six to eight very small undifferentiated scales bordering mouth; ear-opening relatively small; mental small, about half the width of rostral and bordered behind by a pair of somewhat elongate scales (one of these is abnormal in the described specimen), and on each side a series of five or six sublabials bordering the infralabials, diminishing in size posteriorly; scales on chin and neck small, granular, changing abruptly into the larger flat imbricate scales that cover breast, venter, the front part of upper arm, front and underside of femur and tibia; laterally the flat scales pass gradually into the somewhat elevated juxtaposed scales of the sides of the body; about 125 scales about body; scales on base of tail larger than other dorsal scales, equal or slightly larger than ventral scales, becoming

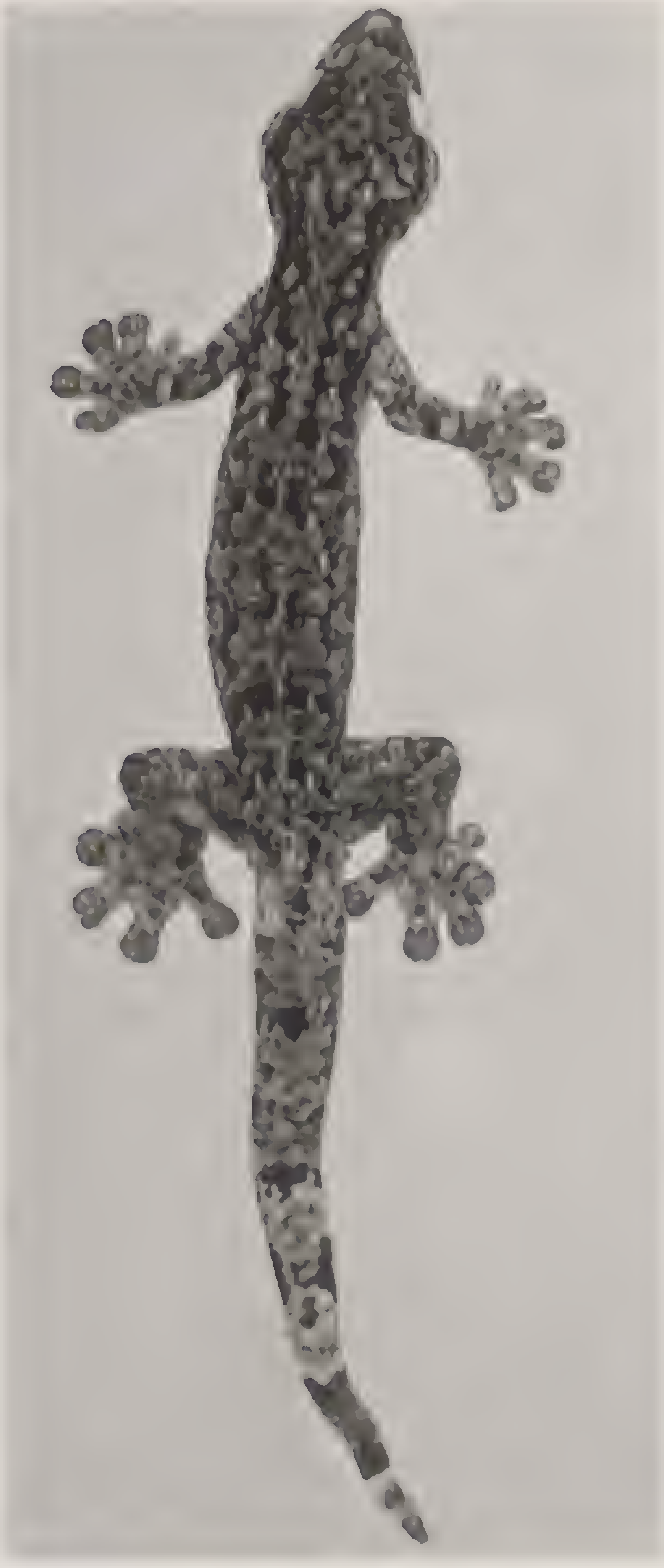

Fig. 14. *Thecadactylus rapicaudus* Houttuyn. Esquinas Forest Preserve (between Palmar and Golfito on railroad), Puntarenas Province, C. R., actual total length, 200 mm.

still larger posteriorly and reducing again in size near tip; caudal scales forming transverse imbricating rows; tail slightly wider than deep.

Hands and feet about half webbed; digits with two series of lamellae separated by a deep groove anteriorly; claws retractile through this groove into a sheath; on dorsal side of digit the terminal joint forms a dorsal elevation but is not free from the widened tip of digit.

Coloration in life: Ground color brownish lavender; supralabials, save for dark upper edges, cream; snout variegated brown; a more or less definite blackish stripe begins behind eye and runs back above the ear towards the shoulder where it becomes somewhat diffuse, the upper border of which is more intensely dark throughout its length; above this a lighter stripe, also black-edged above, runs back on the sides to near the middle of the body, the edges very irregular posteriorly and interrupted by darker indefinite spots; an irregular dark pattern on occiput; on back and across shoulders irregular dark or black marks tending to form six or seven transverse bands between neck and level of hind limbs; tail a little lighter than body with very irregular dark marks tending to form transverse blotches or bands but interrupted dorsally or laterally except for one broad complete band near the end of tail; a terminal band, separated narrowly from the preceding by a narrow cream band, is less dark; venter light lavender, clouded with some darker pigment; arms and legs brownish lavender, spotted or blotched with black; the under side of hands and feet lighter on sole and palm, the outer part of digits blackish. In preservative the lavender appears brownish.

Measurements in mm.: Snout to vent, 113; tail, 87; width of head, 22.2; length of head, 30.2; axilla to groin, 49; arm, 31; leg, 39.

Remarks: Costa Rican specimens examined include the following numbers: Guanacaste Province: KUMNH Nos. 34108-34110, Las Flores, Tenorio, Las Cañas. Puntarenas Province: 34111-34112 Esquinas Forest, between Palmer and Golfito, 34553 Palmar. Limón Province: R. C. T. Coll. No. 1367, Los Diamantes, Gúapiles.

Variation: There seems to be but little observable sexual dimorphism save in the region of the base of the tail. In the males there are two strong swellings, each bearing a large slightly flattened, somewhat shovel-shaped tubercle (the latter scale also present in females but smaller and less conspicuous). I am not able to distinguish any significant color or pattern differences in the sexes save that females may be somewhat lighter. The geographical variation between those from the Caribbean drainage and Pacific drainage areas is scarcely greater than may be found in individuals from the same localities.

In a young specimen from Tenorio, the bands on the anterior part of the tail are more complete, irregular in size, and separated by bands of lighter color.

The regenerated tail is usually greatly thickened at the base, tapering more quickly than the original tail. It is grayish lavender with very numerous short black longitudinal streaks. The scales are smaller dorsally on the greater part of the tail, while those on the latter fifth are larger than in the original tail.

Genus Phyllodactylus Gray

Phyllodactylus Gray, Spicileg. Zool., 1830, p. 3, pl. 3, fig. 1, (type of the genus *Phyllodactylus pulcher*, Tropical America?).

Description of genus: All digits clawed, unwebbed, moderately slender, terminating in a pair of widened symmetrical lamellae, between which is a groove into which the terminal claw is retractile into a sheath; transverse lamella or scales present on under surfaces of digits; upper surfaces of body covered with juxtaposed, more or less uniform granules intermixed with larger tubercles; scales on venter usually cycloid, imbricating; no preanal and/or femoral pores; no specialized glandular scales in preanal and femoral regions; a well-defined elongate lateroventral ridge or fold.

With the exception of *Tarentola* this genus is presumably the only cosmopolitan genus of this family in the Western Hemisphere antedating historical time. It is a populous one, widespread, the species extending from the extreme southwestern United States, western and southern Mexico, south through Central and South America. Species are known in the West Indies and the Galápagos Islands.

Collections I have made in Costa Rica have been notably lacking in specimens of this genus. However, I collected a series at Tenorio, Las Cañas, Guanacaste, in 1952, and in 1954 a few specimens were taken in the general region about Tilarán, Guanacaste. I have seen certain specimens of *Phyllodactylus* from Costa Rica, now in the National Museum; but these specimens are in such a poor state that I hesitate to attempt a specific allocation.

The genus has several species in Mexico, three or four of which may occur in the same locality in the wetter southern part of the country. It is unlikely that the genus should be reduced in Costa

Rica to a single species, confined to the drier part of the country, particularly since there are wet jungle forms farther southward. So I conclude that there is a strong probability that at least another form awaits discovery or recognition in the eastern drainage areas.

A species of the genus described by O'Shaughnessy, as *Phyllodactylus ventralis* purported to be from Jamaica. However the species was purchased from a dealer and the provenance of the specimen may be questioned. I have seen two specimens of this species from Managua, Nicaragua and it is possible this species also occurs in Costa Rica. It may be easily diagnosed by the reduced number of enlarged ventrals, the number being about 16.

The specimens I have collected are referred to *Phyllodactylus eduardofischeri* Martens, described from Salvador. Seemingly they are adapted to a relatively dry rocky habitat, rather than to wet jungle.

Phyllodactylus eduardofischeri Mertens

(Fig. 15)

Phyllodactylus eduardofischeri Mertens, Zool Anz., Bd. 148, 1952, p. 88-89 (type locality, "Westufer des Rio Chilama, bei la Libertad, Dept. La Libertad," El Salvador); Abh. Senckenberg, naturf. Ges., no. 487, 1954, p. 39, pl. 11, fig. 58.

Phyllodactylus tuberculosus Bocourt, (*nec* Wiegman), Mission Scientifique au Mexique et dans l'Amérique Centrale: Études sur les reptiles, livr. 2, 1873, p. 43 (La Unión, Salvador); Werner, Mitt. Nat. Mus. Nat. Hist., vol. 12, 1928 p. 194 (Divisadero, Dept. Morazán, El Salvador); Wettstein, Sitzungsb. Akad. Wiss. Wein, Math-naturw, Kl. Abt. 1, Bd. 143, Heft 1, 2, 1934, p. 19 (Bebedero, Guanacaste Prov., Costa Rica).

Phyllodactylus (indet.) Cope, Proc. Acad. Nat. Sci. Philadelphia, 1871, p. 205 near San José, Costa Rica); Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1876 (1875) p. 118 (presumably same specimen mentioned *supra*); U. S. Nat. Mus. Bull. 32, 1887, p. 28 (*part*).

[It is entirely probable that certain other references to *Phyllodactylus tuberculosus* in Central America, apply to this species.]

Diagnosis: A medium sized species (to 64 mm. snout to vent) the complete tail equal to or a little longer than head and body; ventral scalerows usually 32-34; usually 22-24 granules between middle of eyes; usually 14-16 rows of enlarged dorsal tubercles; supranasals in contact behind rostral; tail segments with several transverse rows of small scales intermixed with larger somewhat keeled flattened scales, the largest marking the posterior row of the vertebral segment; a ventrolateral fold covered with cycloid scales; ventral cycloid-type scales reaching laterally to the outer rows of tubercles.

Description of species (From KUMNH No. 34090 Tenorio, Las Cañas, Guanacaste): Snout oval, the head widening behind eyes; neck distinct; rostral 1⅔ times as wide as high, lowest on median line, the scale with an entrant suture from posterior border, equal in length to half the height, bordered behind by a pair of supranasals forming a median suture, the suture in a deep valleylike depression; nostril surrounded by rostral, supranasal, first labial and two postnasals, the upper large, differentiated; snout covered

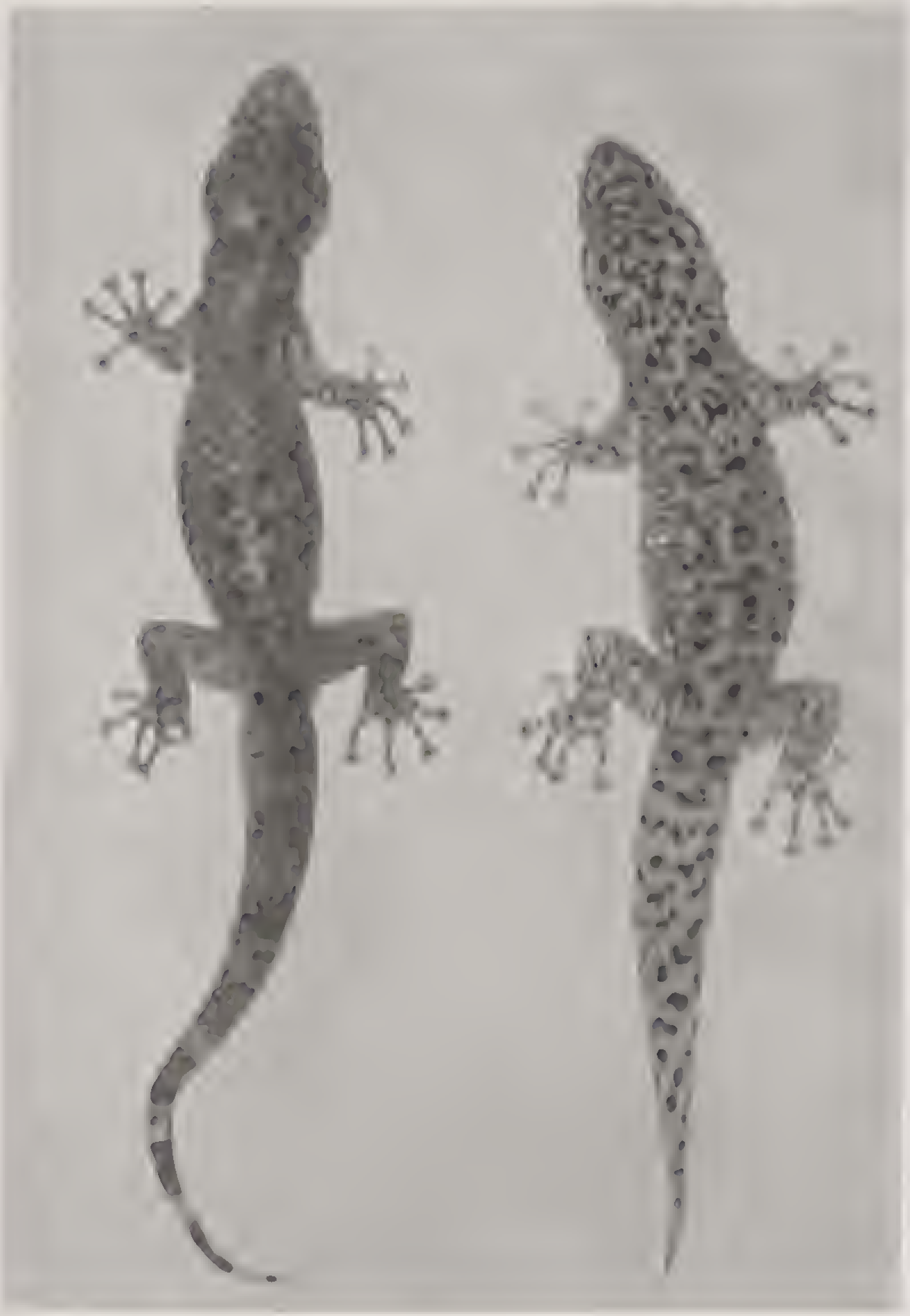

FIG. 15. *Phyllodactylus eduardofischeri* Mertens. Left figure, KUMNH No. 34090; actual total length, 135 mm.; right figure, No. 34101; total length, 119 mm., (tail regenerated). Both from Tenorio, Las Cañas, Guanacaste, C. R.

with moderately large elevated juxtaposed tubercles, largest in front of upper part of orbit; about 28 scales across snout between the posterior end of the third labials. Scales on occiput granular, intermixed with larger scales; sixth supralabial below middle of eye, followed by two diminutive supralabials and three undifferentiated granules; mental with a wider labial border than rostral, narrowed, forming an angle posteriorly, and bordered by a pair of chinshields; a row of five larger chin scales border chinshield, the second row with ten scales; seven infralabials followed by two or three granular scales; scales on chin and front part of neck small, rounded, juxtaposed; eye with spectacle; vertical pupil; ear diagonally vertical.

Granules on dorsum and sides small, intermixed with large trihedral tubercles arranged in about 14 irregular rows at the widest part; the two median rows straight, separated by three or four rows of small granules; below, beginning on back part of neck, scales cycloid, flat, imbricating, about 33 across widest part of venter and extending on sides to enlarged lateral tubercles, about 64 in a row from neck to vent. A ventrolateral fold on which the flattened scales become more elevated. Scales on tail variable, imbricating, intermixed with larger keeled scales, largest being the posterior one of each series of whorls, indicating vertebral segments; a median series of transversely widened subcaudals paired at base of tail and then alternating larger and smaller, two to each segment. On latter third of the tail alternate scales may be paired.

Dorsal and anterior aspect of upper arm and thigh, anterior and ventral aspect of forearm and tibia covered with larger imbricating scales; trihedral tubercles on outer face of forearm and upper posterior face of thigh; posterior part of upper arm and thigh covered with small granules.

Digits unwebbed, palm and sole covered with imbricating scales below, with usually transverse lamella or scales under digits, terminating in a pair of widened lamellae separated by a groove; above these widened lamallae, a sheath covered with specialized scales into which the claw is withdrawn. The lamellae following the terminal widened lamellae paired, 15 under longest toe.

Color: Above fawn, with a paired series of small dark-gray spots or flecks. Other similar darker marks on sides, limbs, and head. Posterior half of tail with about seven dark transverse bars growing black toward tip and surrounding tail. Ventral surface of body, chin, and limbs yellowish. Digits indistinctly banded.

Measurements in mm.: Total length, 136; snout to vent, 64; tail, 72; width of head 14; length of head 18; snout to middle of eye, 9.5.

Variation: The length of the original tail varies in the young and adults. In the youngest specimens with a complete tail, the head body length is 36.2 mm.; the tail 34 mm. In an adult female the same measurements are 64 and 72.

The supranasals are in contact mesially in all specimens, the common suture being in a valleylike depression. The mental, which always has a larger labial border than the rostral, extends back usually to a line drawn across chin from points where the common suture of the first two labials touch the chinshields. A few specimens may extend to a point one millimeter in front or behind this line.

The scales on the regenerated tail are nearly uniform in character. They lack the enlarged tubercular scales and are not arranged in transverse series. The mesial subcaudal scales are usually shorter but distinctly wider than those on the original tail. The dark and light banding is absent, and replaced by small black spots, each covering several scales. The frontal depression is more pronounced in old specimens. I count 24 vertebrae in the tail.

The general dorsal coloration consists of two series of more or less regularly paired dark-gray spots on a fawn ground color beginning on the neck and continuing to the tail. A few specimens show a more or less distinct median lighter line. The ground color may have a lavender shade or it may be a dirty gray color. Below, the chin, venter, and under surface of the limbs are light yellow. In daylight the fawn areas are darker, nearly gray in color.

Remarks: The series of specimens taken at Tenorio (KUMNH, Nos. 34090-34103) is remarkable, in that not a single male is rep-

Measurements of Phyllodactylus eduardofischeri Mertens. Tenorio, Las Cañas, Guanacaste

	Snout to vent	Tail	Head length	Head width	Ventral scales	Scales between eyes	Rows of tubercles
34090	64	72	18	14	33	23+2	14
34101	64	55	19	14.2	32	22+2	15
34098	63.8	....	19	14	32	24+2	14
34091	63	61	17.3	13.2	32	24+2	16
34100	63	67	17.4	14	34	24+2	17
34097	63	34	17.7	14	32	23+2	16
34094	58	55	16	13	32	22+2	16
34093	59	55.5	17	12.8	32	23+2	16
34096	59	59	17	12.8	34	24+2	16
34095	57	50.2	16	12.3	32	24+2	16
34098a	57	55	15.5	12	30	22+2	14
34092	46	....	13	9.2	?	?	?
34103	36.2	28	12	8	30	23+2	16
34102	31.5	....	10	7	31	24+2	....

resented. It suggests that males are either present in smaller proportion than females or that they are more wary than females.

Most of the gekkoes were taken at night at a corral, bordered by a high rock fence partly covered with cactus. Many other specimens seen, escaped. Some specimens were taken on the walls of an adjacent shed. Four young and one half-grown male (KUMNH Nos. 35756-35760) were captured in daytime on boulders in an open field between Tilarán and Los Angeles de Tilarán. The two eggs produced are plastered on a rock, usually on the under surface of a loose rock lying on top of another, or in a covered crevice. Only the empty shells were seen.

FAMILY IGUANIDAE

Iguanidae Gray, Phil. Mag., ser. 2, vol. 2, 1827, p.

This large and populous family, with the exception of certain forms in Madagascar, and members on a few Pacific Islands, is restricted to the Western Hemisphere. In our territory seven genera have representatives. These are: *Sceloporus, Ctenosaura, Corythophanes, Anolis, Polychrus, Basiliscus,* and *Iguana.* Most members of the genera *Sceloporus* and *Ctenosaura* occupy territory north of Costa Rica. The other groups occur both north and south of this country.

KEY TO IGUANID GENERA IN COSTA RICA

1.	Femoral pores absent in both sexes	2
	Femoral pores present, distinct in males	4
2.	Proximal part of digits with widened lamellae; distal part narrow; tail not prehensile	*Anolis*
	Proximal part of digits not widened; infradigital lamellae keeled	3
3.	Head with two ridges uniting posteriorly to form a high crest; toes not lobate	*Corythophanes*
	No head ridges; a dorsal crest on head and dorsum; sometimes a caudal crest; toes lobate	*Basiliscus*
4.	Third and fourth toes equal in length; tail very long, prehensile; body strongly compressed; no head or body crest; a row of elevated scales in median line of chin	*Polychrus*
	Fourth toe longer than third; tail not prehensile	5
5.	A large, nondilatable gular appendage; a large subcircular scute below tympanum; very large lizards (5 ft.)	*Iguana*
	No large gular appendage or sac; no large scales below the tympanum,	6
6.	A dorsal crest; body not or scarcely compressed; large arboreal lizards (2-3 ft.)	*Ctenosaurus*
	No dorsal crest; body much or somewhat flattened; small lizards (5-7 in.)	*Sceloporus*

Genus ANOLIS Daudin

Anolis Daudin, Histoire naturelle générale et particulière des reptiles, vol. 4, An. X (1802), pp. 50-55.

Description of the genus (From Boulenger, 1885): "Tympanum distinct. Body more or less compressed, cylindrical, or feebly depressed, covered with juxtaposed or imbricate scales or granules. Dorso-nuchal crest slightly developed or absent. Male with a gular appendage. Digits more or less dilated, inferiorly with smooth transverse lamellae, the distal joints slender and raised above the basal ones. No femoral or preanal pores. Tail long, cylindrical or compressed, not prehensile. Lateral teeth tricuspid; pterygoid teeth generally present. No sternal fontanelle. Abdominal ribs."

The genus as now accepted is one of the most populous of all reptilian genera. It is confined to tropical and subtropical areas in the Western Hemisphere only one species reaching the United States. The presence of so large a number of species (more than 20 in Costa Rica) suggests strongly that *Anolis* is a composite genus. Certain species formerly in the genus have already been separated into acceptible genera of their own. Other generic or subgeneric names have been proposed that are not at the present accepted.

The problem of making a key for species of the genus *Anolis* has its difficulties, since the variation in various populations of a species may be considerable. I submit the following key based on usual or average external characters, believing that it will be an *aid* in identifying most Costa Rican species. However, once the presumed identity has been established by use of the key, it should be verified by comparison with the description here given, as well as with other descriptions in the literature, if available.

Variation in color pattern is great, with the possible exception of that of the dewlap (throat fan). This usually has a fixed pattern until preserved. Then even the color and markings of this area may be lost. In using size as a key character, it is well to remember that the young or immature specimen of a large form may fall into the category of the lesser species, in which case, if you are in doubt as to age, try the comparable larger category.

KEY TO THE SPECIES OF ANOLIS IN COSTA RICA

1.	Ventral scales smooth, unkeeled	2
	Ventrals keeled	9
2.	Large lizards at least 75 mm.-145 mm. snout-vent length	3
	Small lizards not more than 55 mm. snout-vent length	6

3. No ridge bordering an occipital depression; four subcaudal scale rows enlarged, each with a longitudinal, somewhat serrate keel; one dorsal serrate keel; tail compressed; dorsals small, unkeeled; a small nuchal crest, and a large cherry-red dewlap in males; ear small, double size of nostril; 75 mm.* .... *pentaprion*

Ridges bordering two sides of an occipital depression not meeting posteriorly in midline; two enlarged subcaudal scalerows with strong keels; one dorsal caudal keel 4

4. Ear very small, about size of nostril; dorsal, lateral, and ventral scales small, subequal in size; hind leg reaches jaw angle; 108 mm., *microtus*

Ear larger, three, to many, times larger than nostril; dorsal, lateral, and ventral scales not subequal in size 5

5. A trace of two frontal ridges, not connecting with the circumorbital semicircles; dewlap very large, white or cream in color; medial dorsal scalerows keeled; ear-opening nearly equal to eye-opening; leg reaches in front of eye; ventral scales twice size of dorsals; 125 mm. .... *purpurescens*

No trace of frontal ridges; dorsal and lateral scales rather smooth except for four somewhat enlarged median rows which are subconical; leg reaches almost to ear; ear-opening about half size of eye-opening; dewlaps moderate; 145 mm. .... *insignis*

6. Circumorbital semicircles separated by one scale row; outer postanal scales greatly enlarged; two suborbitals in direct contact with supralabials; occipital scale twice (or more) size of auricular opening, separated from semicircles by three scale series; 40 mm., *biscutiger*

Circumorbital semicircles separated by two or more scalerows; postanals variable 7

7. Head longer than tibia; leg ** reaches to point between eye and nostril, 8

Head a little shorter or equal to tibial length; leg reaches end of snout or a little beyond; head scales keeled, four scalerows between circumorbital semicircles; the scales of semicircles not larger than adjoining scales separating them; occipital scale smaller than ear; postanals not enlarged; 47 mm. .... *pachypus*

8. Circumorbital semicircles separated by three scalerows; suboculars rather large, in contact with supralabials; dewlap small, dull greenish white; occipital scale about equal to ear; smaller, 40 mm., *limifrons*

Semicircles separated by two or three scalerows; suboculars separated from labials by one scalerow; dewlap larger, bright orange; occipital a little longer but less wide than ear; separated (usually) by three scalerows from semicircles; larger, 55 mm. ...... *polylepis*

9. Distinct axillary pockets present; dorsal scales larger than ventrals ... 10

No distinct axillary pockets, although an axillary depression may or may not be discernible; dorsal scales variable 12

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* Measurements given are snout-vent lengths.

** (Except in *trochilis* believed to be a synonym of *limifrons*.)

10. Axillary pocket smaller with an opening about as wide as the depth of pocket; the walls of pocket not scaled or pigmented; size smaller, 40 mm. or less 11

Axillary pocket very large, more open, its diameter usually as great as its depth; walls of pocket partly scaled and pigmented; 12-14 dorsal scalerows enlarged, the two median larger than the adjoining rows, all however equal to or (mostly) larger than ventrals; low nuchal crest; size larger, 44 mm.............*humilis marsupialis*

11. Dorsal eight or ten scalerows enlarged, keeled, the two median rows or parts of the rows, usually smaller than adjoining rows, without trace of dorsal or nuchal crest; dorsal scales considerably (one third or more) larger than ventrals; dewlap deep red orange or red, edged with yellow, without a purple spot at base; 38 mm., *humilis humilis* *

Dorsal eight or ten scalerows about equal in size to ventrals; a bright red dewlap with a purple spot at base; 40 mm., *humilis uniformis* **

12. Hind leg reaches to a point between front of eye and tip of snout.... 13

Hind leg reaches to a point between shoulder and eye........... 17

13. Head scales somewhat multicarinate; tail about twice snout-vent length 14

Head scales largely multicarinate; tail not twice snout-vent length, not distinctly compressed 15

14. Head high, shorter than tibia; 16-18 dorsal scalerows generally hexagonal, juxtaposed, smooth, the median rows not larger than others; no nuchal crest in males; a large axillary depression; posterior supraciliary region with two or three rows of larger scales; upper temporal scales larger than lower temporals; semicircles keeled or roughened, separated normally by two scalerows; about 108 scales around body; tail about double snout-vent length; dewlap small; 90 mm..................................*capito*

Head, not high relatively, its length equal to or longer than tibia; tail 2.3-2.4 times snout-vent length, compressed; scales not hexagonal; an axillary depression; a small nuchal crest in males; upper and lower temporal scales subequal.......................... 15

15. Dewlap large, dark olive to blackish, with magenta scales; body largely brick-red with blackish markings; about 140 scales about body; scales bordering occipital not especially enlarged; 83 mm., *woodi attenuatus*

Dewlap large, pink orange on edge, then a band of amber-yellow, while at base an area of bluish white; many scales on dewlap whitish; body generally olive, with indistinct rusty spots; about 125 scales about body; occipital bordered by two much enlarged scales; 72 mm..............................*woodi woodi*

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* Boulenger's (1885, p. 83) description of *Anolis humilis* is based on *h. uniformis* from Guatemala.

** *Anolis quaggulus* from Nicaragua may represent a population separable from *humilis humilis*, and *humilis uniformis* and it may actually be the proper name to apply to this population. This cannot now be decided by me.

16. Suboculars separated from labials by two scalerows; semicircles composed of relatively small scales, a part of which are multicarinate, the series separated by from five to seven scales; no enlarged postanals; occipital smaller than ear, separated from semicircles by five or six scales; leg reaches nostril; 148 scales around body; 51 mm. . . . . *curtus*

Suboculars larger, two in contact with labials; semicircles of larger scales multicarinate, separated by from three to five scales; occipital about one third of the size of ear, separated from semicircles by four scales; no enlarged postanals; leg to anterior border of orbit; about 160 scales and granules around body; 50 mm., *tropidolepis*

17. Occipital scale surrounded by relatively minute scales, separated from the semicircles by from six to nine rows; two median scalerows enlarged, keeled, larger than adjoining rows, but some lateral scales may equal the median in size; tail compressed, serrate above, banded; suboculars separated from labials by two scalerows; occipital about half as large as ear; about 140 scales around body; 65 mm. . . . . *aquaticus*

Occipital scales not especially small, separated from semicircles by four or less scales; suborbitals touching labials or separated by only one row of scales 18

18. Dorsal scales enlarged in 20-24 rows, usually hexagonal or juxtaposed not or scarcely keeled; largest about equal to ventrals; tail distinctly compressed, not or but dimly banded; postanals enlarged; a shallow axillary depression; occipital scale about equal to ear; about 125 scales around body; 75 mm. . . . . *lionotus*

Dorsal scales not hexagonal, juxtaposed, smaller than ventrals; tail not compressed; postanals variable 19

19. Very large species (102 mm. snout to vent); longest toe to near ear; dorsals small, keeled, ridged or moundlike; the two or four median rows discernibly enlarged; semicircles well defined, nearly smooth, separated by two scalerows; chin usually streaked with brown; body green in life; about 100 scales around body; 102 mm., *biporcatus*

Smaller species 41 mm. to 63 mm. all with more than 100 scales about body, none green in life, none with chin streaked with brown 20

20. Heel with enlarged scales two to three times larger than surrounding scales; seven or eight median scalerows slightly enlarged, none half size of ventrals; leg to ear; about 130 scales and granules around body; occipital scale two and one-half times size of ear-opening; semicircles separated by one scalerow; head scales keeled; 45 mm. . . . . *achilles*

No especially enlarged heel plates; dorsal scales and other characters variable 21

21. Rostral touching anterior nasal scale; suborbitals touching labials; mental divided by a groove; ventral scales equal to or larger than

the two largest median dorsals; about 112 scales around body; small nuchal crest; Cocos Island; 69 mm. . . . . *townsendi*

Rostral separated from nasal by at least one scale; other characters variable 22

22. Scales of semicircles flattened, unkeeled but sometimes with some rugosities; small dewlap 23

Scales of semicircles with single or multiple keels; dewlap large in *cupreus*, unknown in *altae* 24

23. Smaller; two or three suboculars touch labials; no frontal depression; four or five scales between anterior canthals; four loreal series; two rows of median enlarged temporals; four or five scales between upper nasals; largest dorsals nearly size of ventrals; leg to between shoulder and ear; around body about 126 scales and granules; semicircles in contact mesially; 33 lamellae and scales under fourth toe; 50 mm. . . . . *intermedius*

Larger; suborbitals separated from labials (or in contact at one point); eight or ten scales between anterior canthals; semicircles somewhat elevated, separated by one scalerow; rarely a trace of keels; shallow frontal depression; 38 scales and lamellae under fourth toe; about 160 scalerows around body; 63 mm.,
lemurinus lemurinus

24. Two faint prefrontal ridges converging anteriorly; head scales unicarinate or flat to concave; semicircles separated by two scalerows; large supraoculars touch semicircles; six loreal rows; occipital larger than ear, separated from semicircles by two scales; no prefrontal ridges; 52 mm. . . . . *altae*

Dewlap attachment extending to middle of abdomen; semicircles separated by two scalerows; occipital scale double size of ear, separated from semicircles by three (often) tricarinate scales; small; 42 mm. . . . . *cupreus*

Anolis microtus Cope

(Fig. 16, figure on upper right)

Anolis microtus Cope, Proc. Acad. Nat. Sci. Philadelphia, 1871, p. 214 (type locality, San José, Costa Rica, Dr. Van Patten, coll. U. S. N. M. No. 31,282); Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1876 (1875), p. 119, pl. 24, fig. 2; Boulenger, Catalogue of the lizards in the British Museum 2nd ed., vol. 2, 1885, p. 62 (Irazú, Costa Rica, 1 male and 1 female, F. D. Godman, coll.); Dunn, Proc. New England Zool. Club, vol. 12, Aug. 7, 1930, p. 21 (reference to type); Barbour, Bull. Mus. Comp. Zool., Harvard Col. vol. 77, no. 4, June 1934, p. 142 ("Another of the big rainforest forms which we have from La Palma, Costa Rica, collected with *Anolis insignis*"); Dunn, Proc. New England Zool. Club, vol. 15, Jan. 1, 1937, pp. 6, 8 (Boquete, Panamá, 4500 ft. elev., 2 specimens, color changes given).

Diagnosis: A large species, reaching a snout-vent length of 108 mm.; body triangular in cross section; ear small, scales of supraorbital area smooth; scales of the interorbital ridges elevated, rough, separated by two rows of flat scales (one single scale of a third row); a pair of indistinct ridges on snout; a deep occipital depression bordered by occipital ridges; mental partly divided, bordered by

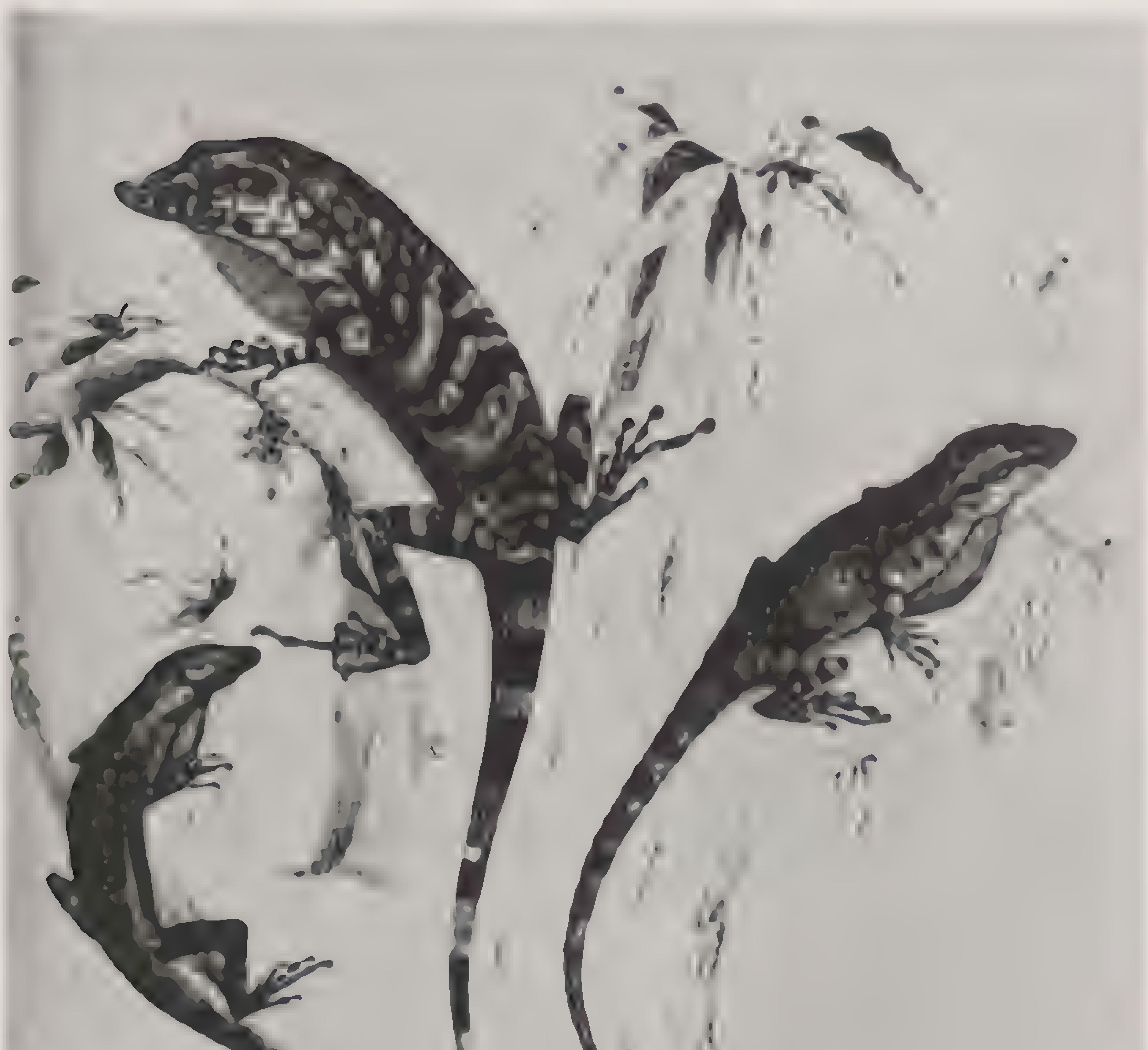

Fig. 16. Upper left, *Anolis oxylophus* Cope, total length, 217 mm. Upper middle, *Anolis insignis* Cope, actual total length, 440 mm. Upper right, *Anolis microtus* Cope, total length, 310 mm.; lower left, *Anolis pachypus* Cope, total length, 135. Lower right, *Chalcidolepis metallicus* Cope, total length, 165. All types, from Cope (1875), pl. 24.

four scales; ear minute (.8 mm. in diameter); hind leg reaches to 5 mm. behind ear; dorsal scales smooth, not or but little smaller than smooth ventrals.

Description of species: Body somewhat triangular in cross section, with a rather sharp dorsal edge; scales of the interorbital rings elevated, very rough, with transverse ridges or tubercles; separated by two rows of flat scales (three at one point) that likewise have some roughened tubercles; canthal series not forming a sharp edge, but are roughly rounded, extending close to rostral; snout with two indefinite ridges; frontal depression marked, the scales covering it smooth; occipital depression bordered by relatively high ridges, which do not unite posteriorly, but leave a notch; the surrounding scales small, rough; rostral moderate, much wider than high, its labial border less than that of mental; mental with a suture entering from behind and extending somewhat more than halfway across scale; mental bordered behind by four scales; six rows of scales between the nasal rings; large supraciliaries absent; supralabials, 9-9, low, smooth, not separated from the subocular series; three or four scale rows in the loreal series; nine infralabials and two or three rows of somewhat enlarged smooth sublabials, the two anterior largest; supraocular area rather small, with one or two larger scales surrounded by two rows of five somewhat enlarged scales, and these by three rows of minute scales all of which are smooth; auricular opening (.8 mm.) not larger than nostril; seven scales between canthi at middle of muzzle; a rather prominent temporal ridge.

Limbs rather short and stout; fingers reaching the tip of snout and posteriorly not quite reaching groin; longest toe reaching to near jaw angle (5 mm. back of auricular opening); the lamellae under the penultimate joint of digits distinctly widened.

Scales of back and sides small, pavementlike, equal (20 in a distance of 10 mm.), not or scarcely larger than ventrals, all unkeeled; tail depressed at base, cylindric distally; "scales on tail and foreleg three or four-keeled"; no enlarged postanals; throat fan large, extending 8 millimeters behind the level of arm insertion.

Color: Generally a rich yellow-brown; a deep-brown band covering eye extends to shoulder, where it is marked with pale-centered ocelli. It is separated above by a narrow paler band from a large dark-brown patch that covers the nape and scapular regions; cross bands of large paler ocelli crossing sides behind axilla, at middle and on rump; ocelli of middle band distinctly larger than others;

limbs and tail banded with brown; belly and throat whitish, unspotted.

Measurements in mm. (*Type*)

Total length	310
Snout to vent	108
Snout to orbit	15
Snout to ear	30
Snout to groin	95
Tail	202
Width of head	17.5
Length of head	32

Remarks: I have seen only the type which is in a good state. It is USNM No. 31282 from "near" San José, Costa Rica. It has been suggested that the specimen may have been obtained at higher elevation than San José. The description given here incorporates data from the type description and from notes made on the type by me.

Boulenger's specimen is from "Irazu," presumably somewhere on the volcano. Dunn has identified two specimens from Boquete, Panamá from 4500 feet elevation, as belonging to this species. I have not seen these specimens. Dunn mentions that the dewlap of his male specimen was pink with white scales.

Anolis pentaprion Cope

(Fig. 17)

Anolis (Coccoëssus) pentaprion Cope, Proc. Acad Nat. Sci. Philadelphia, 1862, p. 178 (type locality, near Río Truando, New Granada, Colombia).

Anolis pentaprion Cope, Proc. Acad. Nat. Sci. Philadelphia, 1874, p. 68 (Nicaragua [probably southern, since the specimen was collected on the Nicaraguan Surveying Expedition of 1873]; "the most northern locality yet discovered for this Anolis."); Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Oct. 1885, p. 47 (Panamá; Ecuador); Boulenger, Catalogue of the Lizards in the British Museum, 2nd Ed., vol. 2, 1885, p. 64 (Guayaquil, Ecuador) (♂ total length, 170 mm.); Dunn, Proc. New England Zool. Club, vol. 12, Aug. 7, 1930, p. 20 (Nicaragua to Colombia); Schmidt, Smithson. Misc. Coll., vol. 89, no. 1, Mar. 16, 1933, p. 10. (Bohio, Panamá [locality now covered with water *fide* Barbour *loc. cit.*]); Barbour, Bull. Mus. Comp. Zool., Harvard College, vol. 77, no. 4, June, 1934, p. 145 (places *sulcifrons* Cope [Colombia] and *panamensis* Boulenger in synonymy); Wettstein, Sitzungsb. Akad. Wiss. Wien, Math.-natur. Kl., Abt. 1, Bd. 143, heft, 1-2, 1934, p. 22 (Porto Jimenez, Costa Rica); Gaige, Hartweg and Stuart, Occ. Papers, Mus. Zool. Univ. Michigan, No. 341, p. 10 (Río Siquia 7 miles above Rama).

Diagnosis: A medium-sized species; body triangular in cross-section, rugose, but unkeeled; the circumorbital scales forming relatively low ridges, one scale of the series much larger than the others; semicircles separated by a single scalerow; four labials in contact with four suboculars; mental almost completely divided, its labial border longer than that of rostral; dorsal scales small, not keeled; ventrals very slightly larger, unkeeled; a nuchal fold or crest in males; two median dorsal rows somewhat enlarged, becoming slightly elevated posteriorly; tail compressed with a low serrate crest; two ventral subcaudal rows much enlarged, keeled; adjoining scalerow somewhat smaller, likewise with strong keels; lateral caudal rows smaller; limbs with small scales, few or none keeled; ear small, a little larger than nostril. Males with a large cherry-red dewlap; 22 widened lamellae under fourth toe; about 186 scales and granules around middle of body.

Description of species (From KUMNH No. 34254, Palmar, Costa Rica): Head relatively long, much longer than wide, the interorbital region a little more elevated than the flat occipital, or frontal regions; rostral wide transversely, about three and one-half times as wide as high, bordered behind by two labials and seven scales; nasal scale separated from the first labial by one scale, from rostral by two, from its fellow by eight scales; snout rather flattened above; head scales rough but not keeled; enlarged scales of circumorbital rings not strongly defined from other scales; behind orbit they become more or less continuous with a row of post- and suboculars. Mental much larger than rostral, with a longer labial border than rostral, its width two and one-fifth times its height, its posterior border irregular, bordered behind by eight scales; supralabials, 12-13, infralabials, 10-11, the posterior of each series much reduced; rows of scales bordering infralabials enlarged anteriorly; four rather elongate scales of suborbital series in contact with labials; larger supraocular scales in about five rows, flat, pentagonal; four or five rows of much smaller scales on outer part of orbit; occipital large, more than twice size of auricular opening, separated from circumorbital rings by two scales; three relatively small supraciliaries on anterior supraciliary border; posterior border with two rows of scales discernibly larger than surrounding granules; auricular opening triangular, small; temporal ridge poorly defined; a small nuchal crest, the two median rows slightly enlarged; scales on body all smooth, unkeeled, scarcely differentiated in size, the dorsal scales very slightly larger than laterals, but discernibly smaller than the small, unkeeled ventrals; approximately 188 scales and granules in a row around middle of body; body rather flattened, not compressed; legs with relatively small scales, all smooth except a very few larger ones on front of forearm and front of tibia, which may have low keels; *scales on dorsal surface of digits smooth;* toes widened conspicuously except on distal part; lamellar formula for hand: 4, 14, 21, 25, 12; for foot: 3, 14, 25, 32, 15; fingers reach nostril but fail

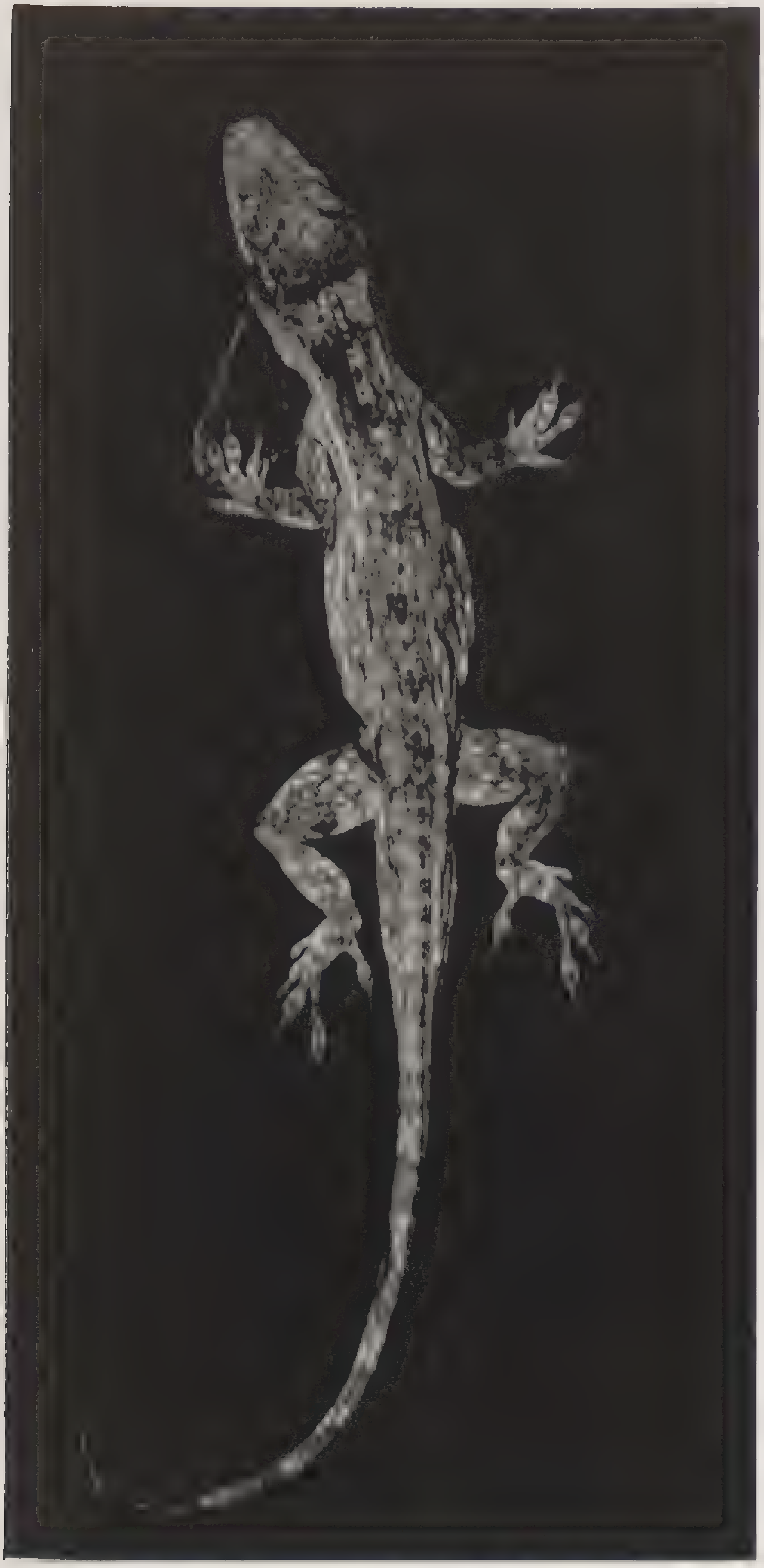

FIG. 17. *Anolis pentaprion* Cope. KUMNH No. 34254, Palmar, Puntarenas Province, C. R.; actual length, snout-to-vent, 71 mm.; total length, 163.

to reach groin; toe fails to reach ear-opening by six millimeters; large throat fan (dewlap) of male reaches back slightly beyond level of arm insertion, its width (distended) 20 mm. Tail compressed, with the four enlarged subcaudal scalerows bearing four strong serrate keels; no enlarged postanals; dorsal scales of tail forming a keel.

Color: In life, grayish, generally with a wash of yellow on venter and thighs; laterally an indistinct light line above shoulder, the sides with numerous larger or smaller lighter whitish-gray areas; arms and legs speckled with lighter above; very indefinite darker dorsal areas and darker and lighter flecks evident on median dorsal line; tail indefinitely banded darker and lighter gray; males with a bright dark-red dewlap.

Measurements of Anolis pentaprion

Number	Type*	34254	34255
Snout to vent	63.52	75	71
Tail	84.68	97	92
Head width	....	13	12
Head length	...	22	21.3
Snout to ear	16.96	19	19
Snout to foreleg	....	31.5	29
Axilla to groin	....	31	29
Arm	....	28	25
Leg	29.04	40.5	40
Tibia	....	15	15

Variation: Cope states in the type description that the hind leg scarcely reaches to the auricular orifice. In these specimens it fails to reach the ear by several millimeters. Moreover, there are four loreal rows of scales instead of three. As is typical of many species of *Anolis* the color and markings vary considerably. The general scheme of color and markings of No. 34255 is as follows: general color above dark gray, with a dark indefinite blotch at nape, one on the shoulder, one across the back behind shoulder and some other irregular smaller dark areas on the posterior part of back. A median series of small fawn marks on the median line. The sides with numerous fawn spots, some subcircular, others more elongate. The tail is indistinctly banded beyond its basal widening. The head is variegated dark gray above, and the labials have light gray markings. The auricular region is light gray and some indefinite darker areas are on the sides of head. The chin is a dirty gray while the venter shows considerable pigment. The under side of arms and limbs and under surface of the base of the tail is gray-white. The widened lamellae become darker distally and the limbs have indefinite light brownish marks. The throat fan is cherry-red, while most of the individual scales on its sides are orange.

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* The type measurements were given in inches and lines. These are here changed to their metric equivalents.

The bright coloration of the throat fans of anoles usually disappears largely in formalin or alcohol; but in this species, after nearly a year of preservation in formalin (then transferred to alcohol), the red coloration has been retained in its entirety.

Remarks: Two male specimens were captured low on the bole of a tree near the bank of Río Diquis at Palmar. No others were seen.

I have examined a specimen, USNM No. 67349 from "Colombiana C. R." and two in Harvard, one from Barro Colorado, C. Z. and one from Balboa, C. Z. These seemingly agree with my specimens in essential characters.

I suspect that this form is most closely related to the preceding *microtus*.

Anolis purpurescens Cope

(Fig. 18)

Anolis ?? *reticulatus* Cope, Proc. Acad. Nat. Sci. Philadelphia, 1862, p. 356 *part.* (Truando, Darien, 4321, jr., Turbo 4313).

Anolis purpurescens Cope, The Philadelphia Museums, Sci. Bull., No. 1, May 26, 1899, pp. 7-8 (type locality, Truando River, New Granada [= Colombia], U. S. N. M. No. 4321, Cope states "The only specimen of the *A. purpurescens* which I have seen is No. 4321 . . ." thus suggesting that No. 4313, noted *supra*, was of another species.); Barbour, Bull. Mus. Comp. Zool., Harvard Col., vol. 77, no. 4, June 1934, p. 147, *part.* ("common on Barro Colorado Island." (Dunn (*infra*) believes specimens regarded as *purpurescens* by Barbour are really *frenatus*); Dunn, Proc. New England Zool. Club, vol. 16, Jan. 1, 1937, p. 9 ("still known only from type").

Anolis longipes Burt and Burt, Trans. Acad. Sci. St. Louis, vol. 28, no. 1, June 1, 1933, p. 18 (*part.*).

Diagnosis: A very large species of *Anolis*, snout-vent length, 125 mm. A deep occipital depression continuous with the interorbital depression; frontal depression shallow; labials and suborbitals separated throughout by a row of scales; two low frontal ridges separated from the circumorbital ridges tending to meet anteriorly; mental broader than rostral, the entrant suture about half the height of scale; mental bordered by from nine to twelve scales; rostral bordered behind by seven or eight scales and two supralabials; one elongate supraciliary; male with enlarged postanals; male with a very large white throat fan; a small throat fan on females; dorsal scales small, upper ones somewhat keeled; lateral scales smooth, flat juxtaposed, all perceptibly smaller than ventrals; ventrals unkeeled; leg reaches to front of eye; lamellae under digits distinctly widened except on distal joint.

Description of species (KUMNH No. 42346): Body triangular in cross-section; head large, the circumorbital scales standing nearly erect, forming a ridge around inner part of orbit and continuous posteriorly with occipital ridges which converge and are connected by a short transverse ridge posteriorly; occipital area forming a deep depression traversed by a slight ridge which crosses the occipital scale; anteriorly, the ridges terminate at the canthus; frontal region shallowly depressed, the area bordered by two low ridges that begin between the orbits, at first diverging, then converging somewhat, and then becoming lost on the slightly elevated area on the snout; areas between these ridges and the canthi forming slight longitudinal depressions; the interorbital trough deep, the bottom curving; occipital scale enlarged, separated from circumorbital semicircles by four or five scales, its size 2 mm. x 2 mm.; rostral about four times as wide as high (6 mm. x 1.5 mm.) its labial border a little less than that of the mental, and bordered behind by two supralabials and eight scales; nostril large, vertical, surrounded by two scales, and separated from its fellow by ten rough keeled scales; canthal edge distinct, composed of six or seven scales. Circumorbital semicircles separated by four scales (at one point by only three); 13 scales between canthi; five rows of somewhat enlarged, bluntly keeled scales on supraorbital area, and seven or eight rows of small conical scales; one large elongate scale on supraciliary border, with two larger scales touching its inner border; twelve supralabials and twelve infralabials; ten outer scale rows on chin larger than the 24 mesial series; mental large, not narrowed laterally, about half divided by a groove entering from behind, the scale bordered behind by nine scales; about eight loreal scalerows; suborbital series keeled, completely separated from the supralabials by a continuous row of scales; a slight temporal ridge with two or three rows of enlarged scales; auricular opening large, approximately 4 mm. x 2.2 mm. (at widest part); length of eye opening 5.8 mm.; scales on body small, convex, somewhat conical on neck, usually unkeeled except near middle of back, nonimbricating; approximately 176 scales and granules in a row around body at level of the back end of throat fan; the median rows a little larger than others and forming a low nuchal crest; ventral scales one and one-half, to twice, size of laterals, lacking keels, tending to form diagonal rows in males (and transverse rows in females); scales on upper arm only a little larger than lateral scales, usually smooth but keeled near elbow; scales on forearm larger, those on the anterior face keeled; scales on dorsal surface of digits much enlarged,

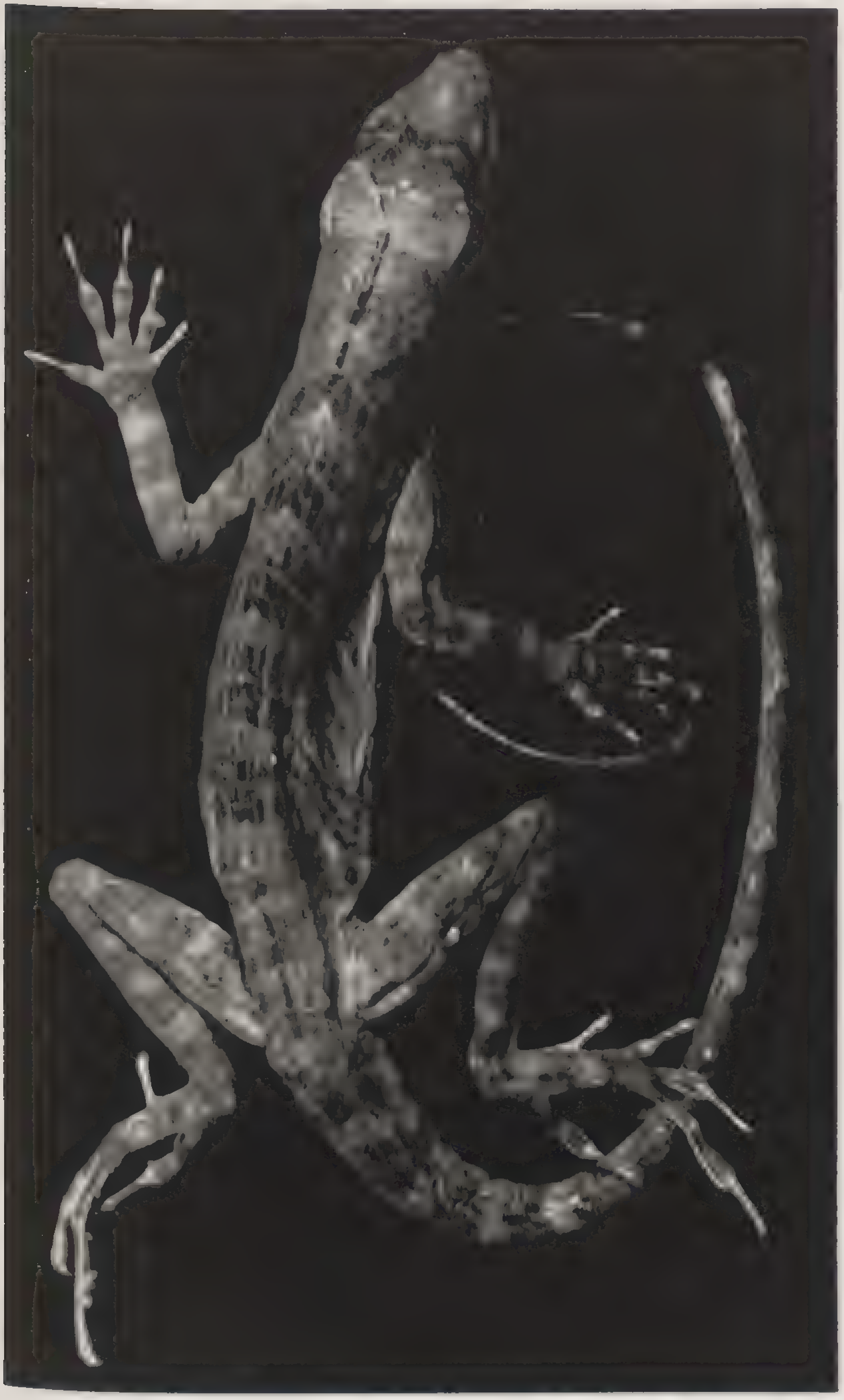

Fig. 18. *Anolis purpurescens* Cope. KUMNH No. 43246. Bataan, Limón Province, C. R.; actual length, snout to vent, 125 mm.; total length, 388 mm.

multicarinate; formula for scales under fingers, counting enlarged basal scales and lamellae, 7, 15, 23, 28, 12; on legs, scales keeled on front of thigh, and larger than those on body; scales on front of tibia are larger while those on dorsal part are smaller than dorsal tibial scales; all tibial scales keeled; lamellar formula for toes, 9, 18, 25, 38, 23; paired dorsal scales on summit of tail for much of its length; large paired ventral scales on tail; all scales keeled except those at base of tail on ventral side; postanals enlarged in males.

Arm fails to reach groin; leg reaches forward to front of eye; tail triangular in cross-section at base, compressed distally; throat fan large extending on venter to a point 20 millimeters behind level of axilla.

Color: In life, green with dim reticulation evident; below cream-white, the dorsal color encroaching on neck; throat fan cream-white. In preservative the dorsum and sides brown with a series of bands sloping down and somewhat backward, these composed of elongate oval or rounded black spots, each two series separated from the next by a lighter yellowish line; a dim dark mark across head; arms and legs dimly barred with darker and lighter brown; tail with bands of dark brown, separated by narrower lighter brown bands; some irregular brown spots on nuchal region; sides of nuchal crest blackish; venter, underside of limbs and base of tail creamy white; darker marking (green in life) along lower jaws, and in the region on either side of neck some ill-defined fine darker and lighter streaks.

Measurements in mm. of Anolis purpurescens

Number	Type	34246	34245
Total length		388	328 inc.
Snout to vent	78	125	122
Tail	.	263	206 inc.
Head length	21+	33	31.3
Head width	13	24.5	24.8
Snout to ear	..	31	30
Snout to arm	..	45	45
Axilla to groin	..	56	53
Arm	36	55	51
Leg	64	101	101
Tibia	.	32	32
Foot	26	45	43

Variation: A second specimen (KUMNH No. 34245, a large female), with one hind leg mutilated, agrees in all essential characters, save in those due to sex. The throat fan is diminutive with some lateral pigmentation. The spotting is similar save that the series of dark oval spots form less distinct transverse series, and the leg bands are more clearly made up of paired series of darker oval spots. This specimen collected by my friend, Sr. Marco Tulio Pacheco, is from Estrella, Limón Province, Costa Rica. In life the Estrella specimen was bright greenish with a trace of the ocellated pattern visible. The throat fan was whitish, while the venter, under parts of the limbs, and an area under the base of the tail were yellowish.

Remarks: The described specimen was captured by me at Bataan, Limón Province on the bole of a forest tree. When first seen it was largely green, changing quickly after capture to a general violet or violet-brown color. The undersurfaces were generally cream white, and these have remained largely unchanged.

From the type description of *purpurescens* these specimens differ in the presence of a pair of very low frontal ridges with a depression between them and likewise a depressed area between these ridges and the canthi (the type "without frontal ridges."); a transoccipital ridge crossing "occipital" scale (none mentioned in type); tail distinctly compressed (height and width, 40 mm. behind vent, 6 mm. x 4 mm.) rather than "cylindric"; occipital scale smaller than auricular meatus ("equal to occipital" scale); circumorbitals erect vertical ("supraorbitals" enlarged, transverse); three or four rows of scales between the circumorbitals ("two rows of flat scales" between series).

Since the type is very much smaller (78 mm. as compared with 125 mm.) it is possible that the differences are, at least in a measure, due to age. The peculiar pattern, the enlarged postanals, the very large creamy whitish throat fan, large hind limb reaching the orbit, the separation of the subocular scales from the supralabials, all bespeak characters that suggest close relationship, and the differences at least in part are those that may be attributed to age.

Anolis insignis Cope

(Fig. 16, upper middle figure)

Anolis insignis Cope, Proc. Acad. Nat. Sci. Philadelphia, 1871, pp. 205, 213-214 (type locality "San José, Costa Rica, Dr. Van Patten, coll.); Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1876 (1875) pp. 120-121, pl. 24, fig. 1; Boulenger, Catalogue of the lizards in the British Museum, 2nd Ed., vol. 2, 1885 (female from Costa Rica, O. Salvin, coll.); Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Oct. 1885, p. 47; Dunn, Proc. New England Zool. Club, vol. 12, 1930, p. 21 ("upper and western Costa Rica"); Barbour, Bull. Mus. Comp. Zool. Harvard Col., vol. 77, no. 4, 1935 (La Palma on the road from Guápiles to San José). Dunn, Proc. New England Zool. Club, vol. 16, Jan. 1, 1937, p. 8. (Cariblanco and Ballena [British Museum specimens], El Valle, Panamá).

Diagnosis: A very large species, (145 mm. *fide* Dunn). Dorsal and lateral scales smooth, one third the size of the smooth ventrals;

four median dorsal rows subconic; leg reaching nearly to ear; auricular opening half as large as eye; scales of arm smooth; mental single without entrant suture; a deep occipital depression continuous with the interorbital depression; scales on top of head smooth; a nuchal fold; two rows of scales on crest of tail.

Description (Data from type description): "Interorbital and occipital regions deeply concave, the latter bounded posteriorly by two elevated osseous ridges which meet behind at an acute angle. No facial rugae, front flat except a light median elevation. Muzzle with a broad median ridge. Scales of the front equal, those of canthus, osseous. Postfrontal and zygomatic arches prominent, rugose. Inferior loreal row of scales larger than others, naris surrounded by small scales. Fan very largely developed. An elevated crest or dermal fold on the nape. Scales of the sides and back (except some median rows) flat, pavementlike, equal, smooth, one third the size of the smooth ventrals. Four median dorsal rows subconic, smaller than ventrals. Tail proximally compressed, covered with equal scales. Limbs stout, the anterior extending four fifths way to groin; the hinder reaching nearly to the ear. Scales of the limbs small; dilations distinct."

The following data are also given. Auricular opening half as large as eye; seven scale rows between orbits, one or two supraorbital rows but little larger than the others; eight rows across middle of muzzle, and six across loreal region at middle. Three large and two small keeled infralabial (sublabial) rows. Scales of arm smooth; those of the tail striate.

Color: Generally fawn brown, with four double bands of greenish blue between axilla and tail. Between these the brown is divided by a yellow band which widens below and breaks into spots above. A large round greenish-blue spot with brown center in front of axilla. A blue spot on the angle of the mandible surrounded by fawn, and this by yellow. Sides of the temporal region

Measurement in mm. of Anolis insignis

Total length	440
Snout to orbit	18.3
Snout to ear	37
Snout to axilla	62
Snout to groin	135
Snout to angle of parietal crests	35
Width of anterior angles of orbits	14
Width at zygomatic arches	19
Length of fore foot	23
Length of tibia	29
Length of hind foot	40

and neck with yellow spots. Bluish of first cross-band in a coarse netted figure. Top of head fawn, face vermillion; belly light yellow. Tail with broad blackish annuli; limbs with dark crossbars, three on tibia, femur, and forearm; two on humerus.

Remarks: The type of this species is lost (*fide* Barbour) and such data as are available on the type is in the published description. The type locality is thought by Barbour to be in the mountains northeast of San José. A single specimen of this species, No. 15439 from La Palma, received in exchange from the Museo Nacional de Costa Rica, is in the Harvard Collection. It agrees with the data given in the preceding description. The following data are from this specimen.

Interorbital ridges border the inner part of the supraorbital area, terminating at canthus, the scales strongly pitted; suborbital series separated from labials by a row of scales; mental single without an entrant suture. Rostral and mental border lip an equal distance; rostral bordered behind by eight scales; nuchal fold strong. Canthal series bordered below by a subcanthal series, their common sutures forming a straight groove; bars on limbs double; tail compressed the double ventral scale series notched behind; a paired dorsal series at crest.

The figure given by Cope shows the throat fan extending some distance beyond the level of the insertion of the arm.

Anolis biscutiger * sp. nov.

(Fig. 19)

Type: KUMNH No. 40771. Collected Golfito, Puntarenas Province, Costa Rica, Sept. 4-8, 1953, by Edward H. Taylor.

Paratypes: KUMNH Nos. 40766-40768; 40769-40770; 40772-40774, Palmar, Nos. 40764-40765, 15 mi. WSW San Isidro del General. All from Puntarenas Province.

Diagnosis: A diminutive anole with smooth ventral scales; occipital more than double size of ear-opening; semicircles form ridges, separated by one scalerow; seven loreal series; two suboculars touch labials; about 150 scales and granules around middle of body; leg reaches a little beyond eye; snout-to-vent length less than 40 mm.; tail about twice head-body length; head longer than tibia; two pairs of postanals, a median and an outer; the outer scales very large proportionally (about 10 times size of surrounding scales).

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* From Latin *bi* = two; *scutum* = shield; *gero* = to carry. Literally carrier of two shields, in reference to two very large postanal scutes.

Description of type: From above, rostral about three times as long as high, visible as a line, bordered behind by two labials and eight postrostrals, separated from nasal by a single scale; eight scales

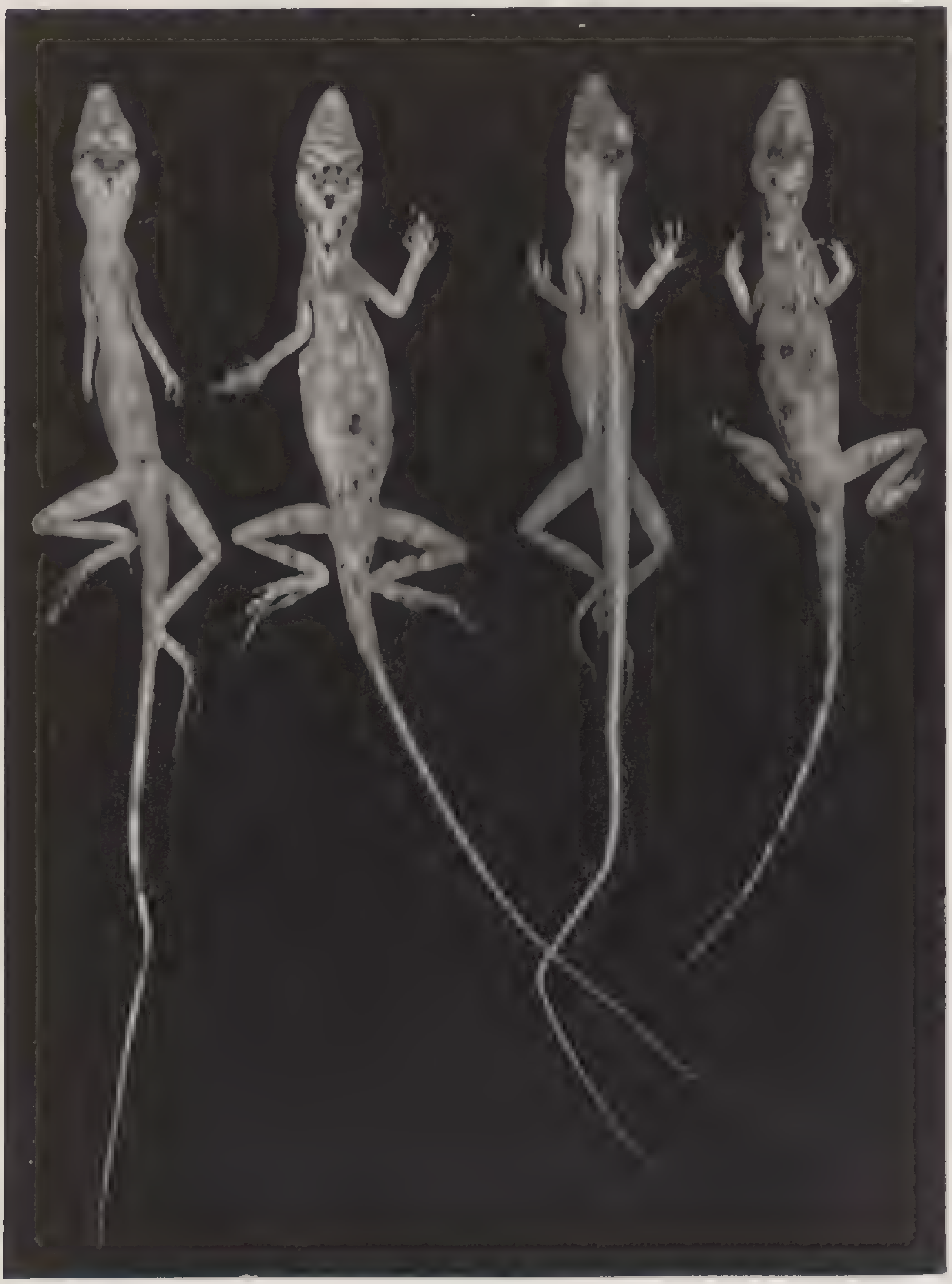

FIG. 19. *Anolis biscutiger* sp. nov. First figure, KUMNH No. 40771 ♂, type; Golfito, Puntarenas Province, C. R.; actual length, snout to vent, 38 mm.; total length 109 mm.; second figure, 40769 ♀, Golfito; actual length, snout to vent, 41 mm., total length, 129 mm. Golfito; third figure, 40770; Golfito, actual length, snout to vent, 37 mm., total 107 mm.; fourth figure, 40768, Palmar, Puntarenas; actual length, snout to vent, 37 mm., total, 84 mm.

between nasals; two supraocular semicircular ridges separated mesially by one scalerow; ridges do not extend beyond anterior level of eye; no distinct occipital depression; interorbital and frontal depressions very shallow; supraocular area with about twenty supraoculars in several rows, the keels dim or obsolete, but scales somewhat roughened; canthus composed of six scales, the anterior small, the series followed by a single much-elongated supraciliary, reaching two fifths the length of the supraciliary region; on the supraciliary border behind this scale there are no enlarged scales; nine supralabials, last two small; about seven enlarged suboculars, two touching labials; seven loreal series; occipital scale large, separated from the semicircles by three series of scales, its size twice (or more) that of the ear-opening; eight infralabials the sixth below middle of eye; mental completely severed by a groove, bordered behind by two labials and eight postmentals; scalerows bordering infralabials somewhat larger than other scales on chin; occipital surrounded by several series of angular scales the area not clearly circumscribed; lateral to these an area of fine granules; the upper temporal rows slightly enlarged, lateral temporals smaller than lateral body scales; scales on venter smooth, lacking keels, in about twenty rows, the scales juxtaposed often transversely oval or subcircular; dewlap small, its depth less than half length of head; ear moderate (1 mm. x 6 mm.); granules on sides minute; on back the fifteen to twenty median rows discernibly larger; caudal scales large, keeled; a median enlarged row of scales on tail slightly serrate; two ventral rows enlarged; a postanal depression with usually four postanal scales, the two outer about ten times as large as adjoining scales; the two median smaller; scales on front of upper arm, on dorsal part of forearm, on front and part of upper part of thigh, and the under surface of tibia as large or larger than ventrals, usually all keeled; the widened part of digits is double the width of the basal, proximal parts; 14 lamellae, and eight scales under fourth finger; 24 lamellae and eight scales under fourth toe. Head longer than tibia.

Color: Above light yellowish olive with dorsal part of head darker about occipital region; a series of tiny dorsal median flecks or spots, the first close to occiput; two dim brown transverse marks near the edge of the supraorbital region; venter yellowish with some scattered brownish flecks; ventral part of thigh cream reticulated with brown; some cream on the ventral base of tail; limbs very indistinctly banded with darker, the toes also banded; tail with olive or brown bands which are a little narrower than the intervening lighter fawn spaces.

Measurements in mm.: Type and 40770 ♀. Snout to vent, 38, 37; tail, 71, 70; snout to ear, 10.2, 10; snout to arm insertion, 18, 17; axilla to groin, 16.7, 16; length of head, 12, 11; width of head, 6.1, 6; arm, 16.4, 16.5; leg, 30, 29; tibia, 10, 10.

Variation: One female specimen figured has a white stripe down the middle of the back, without pigment, covering four to six rows of granules; bordering this are two light stripes with some pigment each covering from five to six scalerows; these on outer edges bordered by a narrow discontinuous brown line; sides grayish with some metallic reflections; cream to yellowish white on venter; base of tail with a median cream mark; a darker occipital spot and a brown line crossing top of head; chin with three dim transverse darker marks; no dewlap in female; tip of snout brownish; a golden circle about eye.

Another specimen has a series of darker median blotches on back and there is a suggestion of a dark line running back from eye to the median nuchal region; there are radiating lines evident below the eye in one specimen. The postanal scales are very conspicuous in all males.

Anolis limifrons Cope

(Fig. 20)

Anolis (*Dracontura*) *limifrons* Cope, Acad. Nat. Sci. Philadelphia, Apr. 1862, pp. 178-179 (type locality, Veragua = [Cucuyos, Veragua Province, Panamá *fide* Barbour); Bocourt, Mission Scientifique au Mexique et dans l'Amérique Centrale; Études sur les reptiles, livr. 2, 1873, p. 65, pl. 14, fig. 2.

Anolis limifrons Boulenger, Catalogue of the lizards in the British Museum, 2nd Ed., vol. 2, 1885, p. 49; Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Oct. 1885, p. 45; Barbour, Occ. Papers, Mus. Zool. Univ. Michigan, no. 129, 1923, p. 6 (Panamá); Dunn, Proc. New England Zool. Club, vol. 12, Aug. 7, 1930, p. 19; Schmidt, Smithson. Misc. Coll., vol. 89, no. 1, Mar. 16, 1933, p. 9 (Canal Zone and Panamá); Barbour, Bull. Mus. Comp. Zool., vol. 77, no. 4, June 1934, pp. 139-140 (synonymy); Wettstein, Sitzungsb. Akad. Wiss. Wien, Math-naturw. Kl., Abt. 1, Band 143, Heft 1, 2, 1934, pp. 21-22 (Costa Rica); Evans, Copeia, 1947, no. 3, Sept. 12, p. 168 (Canal Zone).

*Anolis trochilus** Cope, Proc. Acad. Nat. Sci. Philadelphia, 1871, p. 215 (type locality "near San José" Costa Rica); Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1876 (1875), p. 121 (Costa Rica and Nicaragua); Boulenger, Catalogue of the lizards in the British Museum, 2nd Ed. vol. 2, 1885, p. 50; Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Oct. 1885, p. 45; Cope, U. S. Nat. Mus. Bull. 32, 1887, p. 29; ?Cope, Proc. Amer. Philos. Soc., vol. 31 p. 344.**

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* It would appear very likely that the type of this if actually a synonym of *limifrons* did not originate at San José but at lower elevation. (Cope says "near" San José.)

** Cope reports this form from Palmar and Sierpe, Amer. Philos. Soc., vol. 31, 1893, p. 344. It is quite likely that this reference to a specimen from Palmar belongs in part with *Anolis biscutiger* sp. nov. Cope mentions that a Sierpe specimen no. 384, has a very large fan, and the tail is compressed, with "a rather prominent serrate outline." This may

Diagnosis: A small anole characterized by smooth ventrals; low interorbital ridges formed by the circumorbital semicircles which are composed of eight or ten scales, one scale nearly double size of others, and separated usually by two to three scalerows; median dorsals scarcely larger than lateral granules; postanals somewhat enlarged, separated mesially by small scales; leg reaches to nostril or very near it; occipital about as large as ear-opening, separated from the semicircles by four scale series. A brownish lateral stripe begins behind eye, passes through upper third or fourth of ear-opening, to the side.

Description of species (From KUMNH 40619 Suretka, Limón Province, C. R.): Rostral twice as wide as high, bordered behind by two labials and seven postrostals; ten scales between nasals; circumorbital semicircles forming low keeled ridges that begin back of eye, and reach to the frontal area; interorbital and frontal depressions shallow, with about eight scale series on floor of latter, these preceded by some larger subcircular scales; two series of scales between semicircles; occipital scale about size of ear-opening, separated from the semicircles by four scale series; about three series of keeled supraocular scales, variable in size, separated from the semicircles by granules; a much-elongated anterior supraciliary preceded by four canthals with sharp lateral keels; seven loreal series; subocular series touch labials at one point only; seven enlarged supralabials; eight infralabials; scalerows bordering infralabials somewhat larger than median mental rows; mental scale larger than rostral, more than four-fifth divided by a groove, more than four times wider than high, bordered behind by two labials and six postmentals; dewlap not developed in female, indicated by a faint fold; ventral scales smooth flat or sometimes slightly mound-shaped with some slight indication of keels on sides of breast; ventrolaterally they merge into the minute lateral granules which dorsally become somewhat larger, the median with faint keels, all very much smaller than ventrals; about 150 scales and granules around middle of body; caudal scales enlarged, keeled; median dorsals a little larger than laterals, not or scarcely serrate; two ventral rows enlarged, with brownish keels; scales on upper surface of upper arm, front of forearm, front face of femur, and under side of tibia enlarged, keeled, those under tibia distinctly

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be still another species. Certainty as to whether or not *Anolis pulchripes* Peters (type locality Chiriquí Prov. Panamá), *Anolis rodriguezii* Bocourt (type locality Pansul, Guatemala) and *Anolis bransfordi* Cope (Nicaragua) are synonyms of *limifrons*, awaits the reexamination of these types and confirmation of the findings of Dunn by a competent observer. Barbour was not wholly convinced (Bull. Mus. Comp. Zool., vol. 77, 1934, p. 140) that only a single form was represented.

larger than ventrals; about fourteen widened lamellae and six scales under fourth finger; twenty three lamellae and seven scales under fourth toe; leg reaches to a point between orbit and nostril nearer the latter.

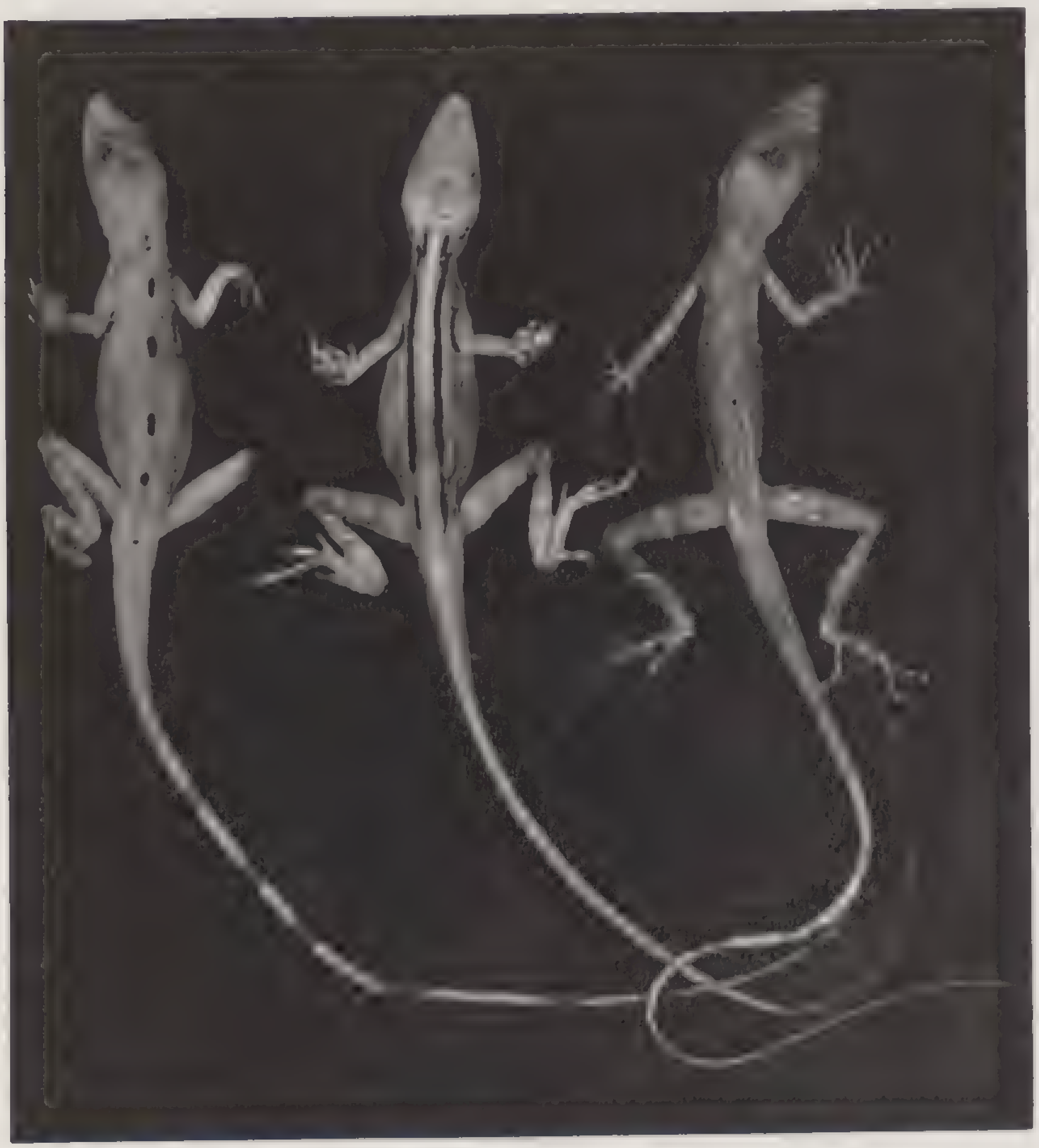

FIG. 20. *Anolis limifrons* Cope. Left figure, KUMNH No. 40619 ♀; actual length, snout to vent, 39.3 mm.; total 127 mm.; middle figure, 40591 ♀, actual length, snout to vent, 40 mm., total length 130 mm.; right figure, 40610, actual length, snout to vent, 41 mm., total length, 130 mm. All from Suretka, Limón Province, C. R.

Color: Dorsum olive the tail lighter olive with well-defined bands of darker olive brown; chin whitish, the venter greenish white or greenish yellow, the base of under side of tail with bronzy reflections. In male the dewlap is white or grayish white, with a very slight orange mark visible at base; greenish under limbs. A series of black spots along middle of back; a dim lateral brownish band; a dim band on limbs.

Measurements in mm.: Snout to vent, 40; tail, 90; snout to ear, 10.2; snout to arm insertion, 15.5; axilla to groin, 18; head length, 12; head width, 6.2; arm, 16; leg, 32; tibia, 10.

Variation: One of the color variations confined to females is a median cream stripe covering ten to twelve rows of scales, and flanked by two black stripes each covering about five rows of scales; the brown stripe from eye to side is distinct; there may be a few small darker flecks on the chin, upper arm, and on the posterior part of thigh; the supraorbital areas, and the occipital areas dark; a small frontal spot.

Often the dim brown stripe behind eye appears to divide at about the level of the ear and a part tends to run up and back to join its fellow on the postoccipital region on neck. This is dim in preserved specimens. The species is represented in the collections chiefly by specimens from the Caribbean drainage areas. However the species occurs in Guanacaste Province in the Pacific drainage. These specimens seem to show no more variation than occurs in the eastern specimens.

I shall not attempt to list localities for *limifrons.* It appears to be omnipresent from sea level to an elevation of 2000 feet; it probably occurs considerably higher than this but certainly is less conspicuous. This with the small *humilis* are the two most common anoles in Costa Rica, or at least the two most easily collected.

Anolis polylepis Peters

(Fig. 21)

Anolis polylepis Peters, Monatsb. Akad. Wiss. Berlin, 1873 (Jan. or Feb. 1874) pp. 738-739 (type locality, Chiriquí, Panamá); Boulenger, Catalogue of the lizards in the British Museum, 2nd Ed., vol. 2, 1885, p. 52; Cope, U. S. Nat. Mus. Bull., no. 32, 1887, p. 31; Dunn, Proc. New England Zool. Club, vol. 12, Aug. 7, 1930, p. 20 ("close to *pentaprion*"); Barbour, Bull. Mus. Comp. Zool., Harvard Col., vol. 77, no. 4, June 1934, pp. 146-147 (5000-6000 ft. on Volcán Chiriquí).

Diagnosis: Rather small species, length 50-55 mm. snout to vent; scales small, dorsal scales only slightly larger than the laterals, however, two median rows discernibly larger than others; ventrals smooth, small, juxtaposed but often not touching one another; male dewlap large, extending behind thorax slightly, scarcely discernible in females; supraorbital semicircles slightly elevated, composed of enlarged keeled scales separated mesially by two or three scalerows; loreals in six or seven series; 150-160 scales and granules in a row round middle of body; tail length double snout-vent length; postanal scales only slightly enlarged; leg reaches to nostril or near it.

Description of species (From KUMNH 34405, Esquinas Forest Preserve, between Palmar and Golfito, Puntarenas Province): Rostral little more than three times as wide as high, bordered behind by two labials and nine postrostrals; nine or ten scales between nasals; five enlarged canthals with a rather blunt edge; front supraciliary border with two supraciliary scales, the anterior much the larger, partly overlapping posterior; back part of supraciliary border with only minute granules; supraorbital semicircles each composed of nine scales, only slightly elevated, keeled, separated between orbits by two scalerows, anteriorly by six or seven rows; about eight or more supraocular scales, in two irregular rows, the inner row largest, all separated from the semicircles; supraocular almost exactly size of ear-opening, separated from the semicircles by three rows of angular scales; outer occipital scales and temporals, minute granules; most of scales on snout keeled while those in the frontal depression nearly smooth, or at most, slightly rugose; seven series of loreal scales; suboculars relatively small, separated from labials by a granular scale series; nine supralabials, seventh below middle of eye; rostral separated from nasal by a single scalerow; mental divided by a groove, larger than rostral, its width about three times its height, bordered behind by two labials and eleven small postmentals; nine infralabials, the last two very small; six or seven scalerows below infralabials, larger than median scalerows on chin; gular dewlap rather elongate, reaching back of thorax, the scales on it relatively small, the largest on its ventral edge. Tail distinctly compressed with a slight dorsal keel at base; caudal scales all large, keeled, the median dorsal row larger than adjoining scales, strongly keeled, somewhat serrate; two ventral rows also enlarged; a row of postanal scales slightly enlarged; dorsal body scales a little larger than laterals, the two median rows largest and slightly keeled; ventrals relatively small, smooth, sometimes separated, juxtaposed, or on anterior part of venter slightly imbricating; keeled scales on upper surface of upper arm, front and dorsal parts of forearm, on front face of thigh, and most of the scales on tibia, as large as, or larger than ventrals; digits widened except on distal part; 14 or 15 lamellae under widened part of fourth finger, ten scales under distal joint; 24 lamellae under fourth toe, and nine scales under distal joint. Depth of dewlap almost equal to head length; head as long as or slightly longer than tibia; leg to nostril.

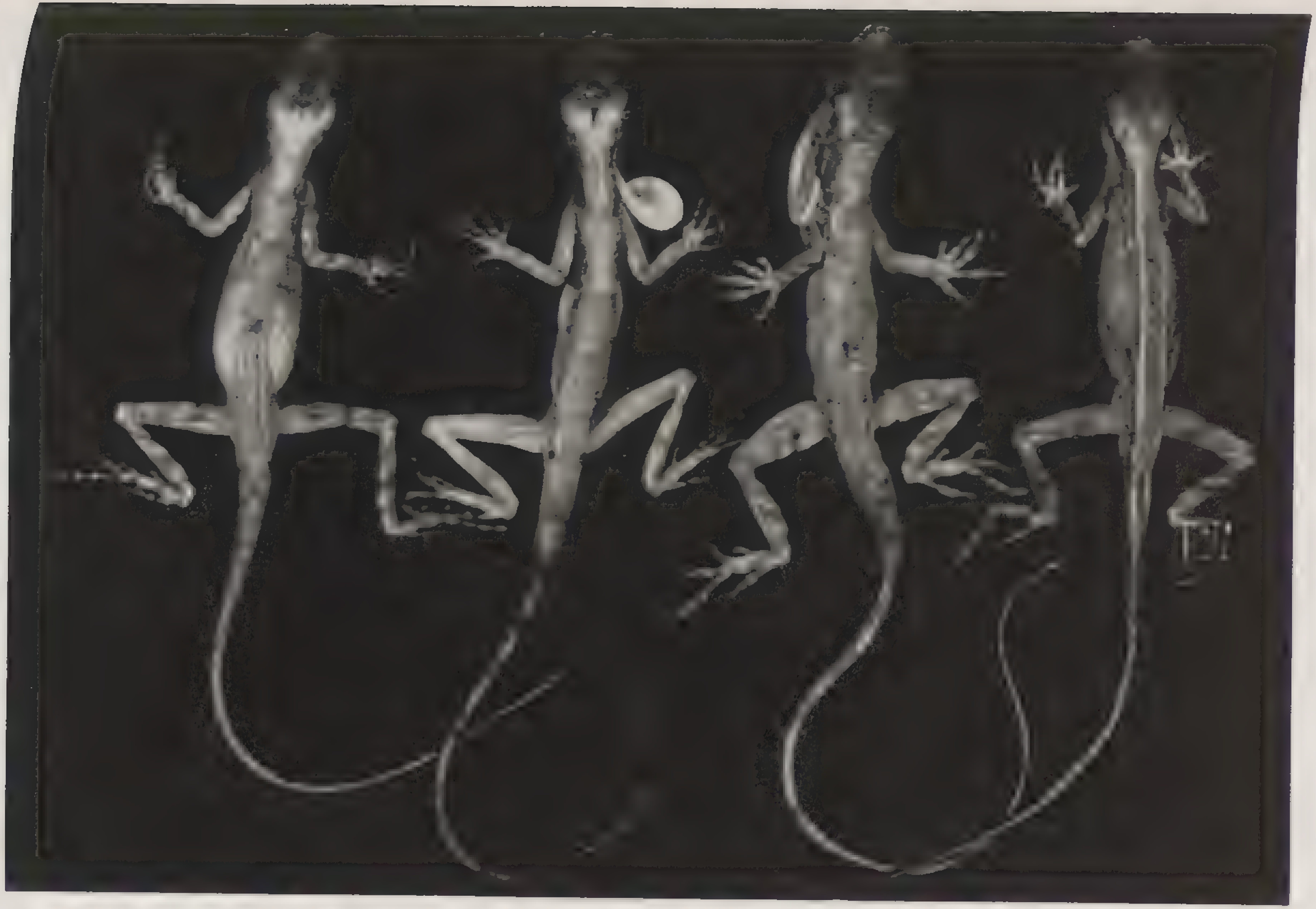

FIG. 21. *Anolis polylepis* Peters. First figure, KUMNH No. 34351, Palmar, C. R.; actual length, snout to vent, 48 mm., total length, 127 mm. (tail regenerated); second figure, 40666, Agua Buena, Cañas Gordas, actual length, snout to vent, 51.5 mm., total, 158 mm.; third figure 34354, Palmar, actual length, snout to vent, 49 mm., total length, 154; fourth figure 40658, Agua Buena, Cañas Gordas, actual length, snout to vent, 47.5 mm., total length, 139 mm.; all from Puntarenas Province, C. R.

Color in life: Nearly uniform light olive brown above and on sides, cream-white on ventral surface. Dewlap bright orange; tail brownish above and below; under a lens almost every granule has a tiny black spot; legs with dim bands of brown; an indefinite dark line passes above arm and continues on the side for some distance; a few darker flecks on chin and faint indication of radiating lines below eye; tail nearly uniform fawn color.

Measurements in mm.: Snout to vent, 52; tail, tip regenerated, 92; snout to ear, 13.4; snout to arm insertion, 21.2; axilla to groin, 20.8; head length, 15.8; head width, 8; arm, 23; leg, 43; tibia, 14.6.

Variation: Color variation occurs, as is to be expected. Many of the females have a lighter median stripe which may be generally fawn with a median darker center and bordered laterally by a broad band of deep brown which begins behind the eye. A few specimens have a series of blackish brown median spots connecting with the brownish lateral stripe by scarcely discernible brown chevrons. A black spot is often present on the neck, and the tail is more or less distinctly banded. In some females the median stripe may be brownish black bordered laterally by narrow fawn lines. In such, the dark brown lateral line is present and the tail is dark brown without bands. One female with brown dorsal spots has a series of rounded gray spots nearly white-edged alternating with the brown spots. This continues on to the tail.

Many of the specimens show a dark, rather indistinct band across the head and many of the females have a rather heavy ventral pigmentation.

Remarks: Dunn, *loc. cit.*, suggests that the species is related to *Anolis pentaprion.* However, the reduced limbs, the presence of a nuchal crest, fewer loreals, reduced ear-opening, the contact of suboculars and labials, the very different character of the "pentaprion" tail all point to a form very widely separated from *polylepis.* Moreover, the ventral scales are in about fifty rows while in *polylepis* the number is less than half this number. The character of the superciliaries are quite unlike those of *polylepis* and the dorsal squamation of head, especially of the supraorbital region, differs almost as much as can be found between two species within the genus.

Specimens usually found on low shrubs, are easily taken.

All the specimens in the collections at hand were obtained in southwestern Costa Rica. The following localities are represented: Puntarenas Province: KUMNH Nos. 34348-34358, Palmar; 34400-

34408, Esquinas Forest Reserve between Palmar and Golfito; 40648-40671, Agua Buena, Cañas Gordas. San José Province: Nos. 34359-34371, San Isidro del General and vicinity (including points 10-15 km WSW).

Anolis humilis Peters

This species is represented in Costa Rica by three recognized subspecies. The most common form *h. humilis* occupies territory on the northern and eastern lowland areas, ascending to some 4000 ft. elevation at least at some points; *h. marsupialis*, here described as new, is seemingly confined to the southwestern lowlands, while the form here identified as *h. uniformis* is from the northwestern lowland area.

With the exception of *Anolis limifrons, A. humilis* is the species most frequently encountered in forest. *Limifrons* however, is less confined to forested areas and in the abacá plantations at Bataan it was especially numerous. In the same place *humilis* was rare save in areas where there were forest remnants standing nearby.

KEY TO SUBSPECIES OF ANOLIS HUMILIS IN COSTA RICA

1. Dewlap bright red, with a purple spot in its basal part; eight or ten dorsal scalerows enlarged, about equal to ventral scales in size; head scales of semicircles nearly undifferentiated from the scales adjoining them; no nuchal crest in males; axillary pouch rather small; 40 mm. .... *humilis uniformis*

   Dewlap red or red-orange without purple spot 2

2. Twelve to fourteen enlarged dorsal scalerows, the two median rows larger than adjoining rows, and equal in size to ventral scales; a low nuchal crest and often a trace of a dorsal crest in males; lateral scales small with distinct keels pointing upwards and backwards; axillary pouch large, the sides of pouch at least partly scaled and pigmented; size larger, 44 mm. .... *humilis marsupialis*

   Dorsal eight or ten scalerows enlarged, the two median rows usually smaller than adjoining scales; larger dorsal scales one third (or more) larger than ventral scales; no dorsal or nuchal fold or crest in males; axillary pouch smaller, the side walls not scaled or pigmented; size smaller, 38 mm. .... *humilis humilis*

Anolis humilis humilis Peters

(Fig. 22)

Anolis humilis Peters, Monatsb. Akad. Wiss. Berlin, 1862 (1863), pp. 138-139 (type locality, Veragua, Panamá, collected by von Warszewicz); Bocourt, Mission Scientifique au Mexique el dans l'Amérique Centrale; Étude sur les reptiles, livr. 2, 1873, pp. 105-106, pl. 13, fig. 7, 7a; pl. 16, fig. 31; Cope, U. S. Nat. Mus. Bull. 32, 1887, p. 30 (listed); Boulenger, Catalogue of the lizards in the British Museum (Natural History), 2nd Ed., vol. 2, 1885, pp. 82-83 (Verapaz, Guatemala; probably *Anolis humilis uniformis*); Dunn, Proc. New England Zool. Club, vol. 12, Aug. 7, 1930, pp. 16, 22, 24.

?*Anolis quaggulus* Cope, Proc. Amer. Philos. Soc., vol. 22, July 29, 1885, p. 391 (type locality, Rió San Juan, Nicaragua).

Diagnosis: A small terrestrial species living in forest, maximum snout-vent size about 38 mm.; a deep axillary pocket, its walls without scales; dorsal eight or ten scalerows enlarged, keeled, the two median usually a little smaller than adjoining rows, without trace of dorsal or nuchal crest in males; dorsal scales one-third, or more, larger than ventrals; dewlap red or red-orange edged with yellow, without a purple spot at base.

Description of species (From KUMNH No. 40960, Suretka, Limón Prov. Costa Rica): Rostral with a narrower labial border than mental, about four times as wide as high, bordered by two supralabials and eight postrostrals; two scales between rostral and nasal ring; eight carinate scales between nasals; a slight frontal depression; circumorbital semicircles somewhat larger than other head scales, somewhat elevated anteriorly, separated anteriorly by three scales, mesially by two scalerows; no occipital or interorbital depression; five or six enlarged supraoculars, two scales usually larger than others, but all separated from semicircles by an irregular row of smaller scales; head scales keeled, the edges of many scales somewhat upturned causing the scales to appear tricarinate; four canthal scales lying somewhat diagonally, their keels not forming a continuous line; two anterior supraciliaries much elongated, overlapping; posterior supraciliary region with small granular scales; occipital very small, about one fourth to one fifth of the size of ear, and surrounded by scales many equally as large or larger than the occipital itself, separated from the semicircles by three scales; loreal scales in six or seven rows; scales of upper temporal region larger than lateral temporals; two enlarged rows of temporals begin behind eye; eight or nine supralabials at least part of them keeled; suboculars separated from the supralabials by a row of small scales, but they may be in contact at a single point; about seven infrabials (on one side scales fused); five scalerows bordering the infralabials enlarged; mental partly divided by a groove and bordered behind by two infralabials and six irregular scales.

About ten dorsal scalerows enlarged, keeled (sometimes tricarinate), most of them larger than ventrals, the scales of the two median rows very often smaller than those in adjoining rows; lateral scales granular; no dorsal or nuchal crest in males; about 84 scales

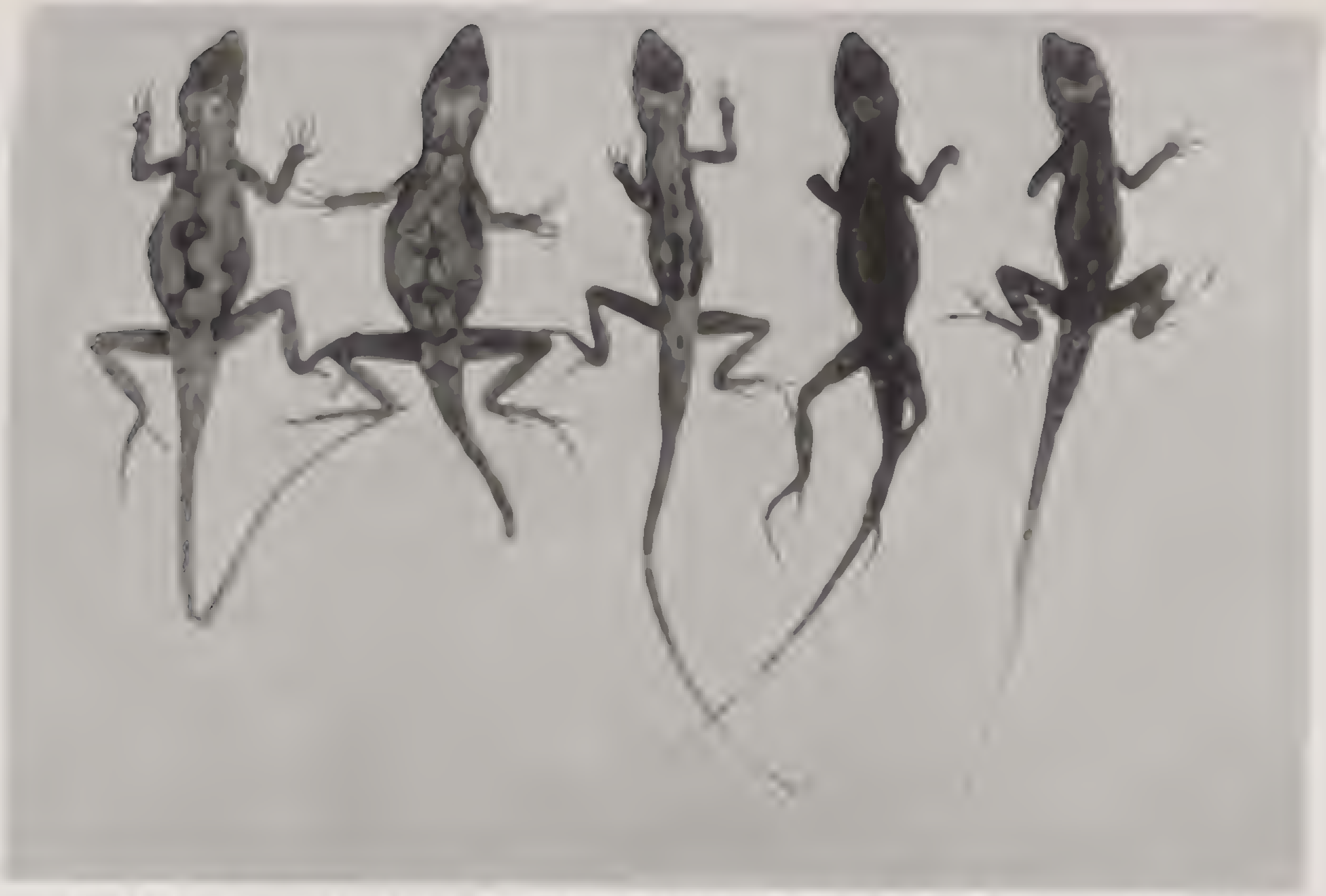

Fig. 22. *Anolis humilis humilis* Peters. First figure. KUMNH No. 40882 (with ovarian eggs) actual length, snout to vent, 39 mm.; second figure, 40882♀; third figure, 40847♂; fourth 40859♀; fifth figure, 40823♂; actual length, snout to vent, 39 mm. All from Moravia de Chirripó, Limón Province, C. R.

and granules about middle of body; caudal scales large, keeled, the median dorsal row only a little larger than adjoining scalerows and not or but slightly serrate; two subcaudal rows enlarged with continuous keels; no enlarged postanals.

Scales on dorsal part of upper arm and the front and dorsum of forearm enlarged but smaller than dorsals on body; scales on front and upper side of thigh, and those on front and upper surface of tibia large, some as large as dorsal body scales; lamellae under proximal joints of toes only slightly widened; scales and lamellae under fourth finger 19; under fourth toe, 25; hind leg reaches to middle or front of eye. Dewlap moderate, distended, its depth a little less than head length.

Color: Above and on sides of body rather dull brownish olive; venter light flesh with some pigment; yellowish-white line under tail; throat fan reddish with a yellow border; supraorbital and interorbital area a little darker than remainder of head; some small yellow spots on back of thigh.

Measurements, in mm.: Nos. 40960 ♂ and 40961 ♀ : Snout to vent, 33, 37; tail, 58, 55; total length, 91, 92; snout to arm insertion, 15.3, 15.1; axilla to groin, 12.6, 15; length of head, 11, 11.2; width of head, 6.2, 6.8; arm, 15, 15; leg, 26, 26.5; tibia, 9, 9.2.

Variation: In the large series of this species available to me there is considerable variation. The largest specimen measures 40 mm. in snout-vent length. The character of the dewlap remains nearly constant as to size and color.

In color and pattern there was a marked range, some specimens being dark olive above and rather creamy or whitish below; others were dirty brown and rusty olive below. In females there were often somewhat distorted dorsal chevrons, or distinct spots, sometimes large, sometimes small; some specimens had the dark markings arranged longitudinally in two or four rather indistinct lines. None of the females seemed to develop a median cream stripe such as occurs in many species of the genus.

Remarks: This species described from Panamá, is one of several forms having the strongly developed axillary pocket, which has seemingly been overlooked by previous students of the group. There are several species or subspecies recognized beginning with *tropidonotus* and *uniformis* in the north,* perhaps *quaggulus* in

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* Smith and Kerster have recently described a form, *Anolis compressicauda* from Oaxaca, Mexico, related to *tropidonotus* and *uniformis.* Herpetologica, vol. 11, 1955, pp. 193-198, figs. A and B.

Nicaragua, *humilis* in Costa Rica and Panamá, and *marsupialis* in southwestern Costa Rica (perhaps also in Panamá).

In the Costa Rican material of *humilis* I find a number of female specimens with dorsal markings suggesting those of *quaggulus*. However Cope's description of that species mentions a large throat fan showing its male sex. The golden green color and the vertical lateral lines dividing the sides into separate areas, and the yellowish head, suggest that it may represent a separable population. Since the type locality is Río San Juan, on or near the Costa Rican border, such specimens should be looked for in the northern part of Costa Rica. Cope described *quaggulus* in the same paper with *uniformis* and states that it is allied to that species and to *tropidonotus* Peters.

The name *humilis* is well chosen since it is indeed an earth anole. I have found it on the ground, in piles of trash or brush, on low plants, or on fallen logs. To escape, it seeks refuge on the ground rather than ascending to higher elevation.

The functional significance of the axillary pouch is difficult to explain. It is ample enough to hold ten or fifteen larval chigger mites. Certain pouches contain as many as ten; others may contain a smaller number, while some lack the parasites.

Four specimens harboured, below the skin, larvae of an insect still unidentified. These formed conspicuous cysts.

Specimens in the KUMNH collections are from the following localities: Heredia Province: Nos. 40779-40791, 40897-40900, 40933, Isla Bonita (Cinchona); 40901-40904, Cariblanco. San José Province: ?40926, La Carpintera Mt.; 40927-40929, Tapantí. Cartago Province: Nos. 40775, 40798-40800, 40819-40822, 40905-40908, 40930-40931, Turrialba; 40879-81, Tuís; 40777, Santa Cruz; 40776-40778, Morehouse Finca, 4-5 mi. from Turrialba; 40793, Navarro. Limón Province: 40792, 40920-21, Los Diamantes, Guápiles; 40794-40797, 40823-40878, 40882-40888, Moravia de Chirripó; 40801-40818, Bataan; 40909, Limón; 40910-40916, Mountain Cow Creek; 40933-40949, 40952-40958, 40963-40965, Suretka; 40959-40961, Volio (near Suretka).

Anolis humilis uniformis

Anolis uniformis Cope, Proc. Amer. Philos. Soc., vol. 22, no. 4, July 29, 1885, pp. 391-392 (type locality, Guatemala and Yucatán (restricted to 2 mi. N Santa Teresa (El Petén, Guatemala), by Smith and Taylor); Boulenger, Catalogue of the British Museum, vol. 2, 1885, p. 84; Stuart, Occ. Papers Mus. Zool. Univ. Michigan, No. 464, 1942, pp. 1-2.

Anolis humilis uniformis Stuart, Misc. Publ. Mus. Zool., Univ. Michigan, No. 69, 1948, p. 48; Smith and Taylor, U. S. Nat. Mus. Bull. 199, 1950, p. 60; and Univ. Kansas Sci. Bull., vol. 33, pt. 2, no. 8, Mar. 20, 1950, p. 318.

Anolis ruthveni Stuart, Occ. Papers Mus. Zool. Univ. Michigan, no. 310, 1935, pp. 1-4 (type locality 2 mi. N Santa Teresa, El Petén, Guatemala).

Diagnosis: A small form 40 mm. or under in snout-vent length; a well-developed axillary pocket; eight or ten dorsal scalerows enlarged, the two median smaller than adjoining scales about equal or larger than ventral scales; about 100 scales and granules around body; scales of the semicircles a little larger or not than the adjoining scales, usually slightly elevated; occipital scale less than a third of ear-opening, not larger than other scales in occipital area, which occupy all the upper temporal region. Dewlap with a purple spot on base of red.

Description (From KUMNH No. 40893, Tenorio, Guanacaste, Costa Rica): Rostral very low its width more than five times its height, touched posteriorly by two labials and seven postrostrals; eight (or seven) scales between the tiny nasal scales; circumorbital semicircles consisting of about eight scales, the two anterior largest, separated from the canthal edge by a large scale, all with a single strong keel and certain other rugosities, separated mesially by three scale rows; many anterior scales in the shallow frontal depression and on the snout have the outer edges upturned suggesting a tricarinate condition; about four canthals, the anterior small the posterior larger and contiguous with anterior of two large supraciliaries; posterior supraciliary edge with only slightly enlarged scales; area of occipital less than a third of ear-opening distinctly smaller than scales in the outer occipital region; scales of upper temporal region larger than those on lower part; seven supralabials, low, elongate, keeled at lower edge, the posterior end of sixth below middle of eye; eight infralabials; five rows of scales below infralabials enlarged, keeled; mental wider but a little higher than rostral, nearly severed by a median groove, bordered by two labial and six postmentals; suborbitals separated from supralabials by a row of scales; supraoculars in two or three rows of larger scales, separated from the semicircles by a row of smaller scales.

Eight rows of dorsal scales enlarged, more or less keeled, the two median smaller than the three scalerows on each side of them; the row bordering these enlarged scales may itself be abruptly larger than the elevated lateral granules; a pair of enlarged scalerows begins at occipital region, at first larger than anterior granules of neck; in middle of nuchal region there is a small group of scales usually discernible larger than surrounding enlarged series; ventral scales scarcely more than a half as large as the larger dorsals, the scales keeled, and elevated posteriorly suggesting a leaning pyramid in profile; (no enlarged postanals in males); dorsal scales on arm and leg enlarged, keeled, some of them approaching size of dorsals; scales above digits, polycarinate; subdigital lamellae widened on basal joints; lamellae and scales on distal joint 28 under fourth toe; leg extended, the longest toe reaches orbit.

Color: Dark dirty olive brown with traces of two dark longitudinal stripes bordering the outer enlarged scalerow; head olive, with a trace of a line between eyes; venter brownish white; throat pinkish in females (in males dewlap red with a purple basal spot).

Measurements in mm.: Snout to vent, 38; tail, 47; snout to ear, 10; snout to arm insertion, 15; axilla to groin, 16.5; length of head, 11; width of head, 7; arm, 15; leg, 29.

Remarks: Four specimens are in the collection from Tenorio, Las Cañas, Guanacaste Province.

There is some question as to the wisdom of regarding these northwestern Costa Rican specimens under this name. With the exception of the curious coloration of the dewlap, there seems no character that cannot be duplicated in at least some specimen in the series at hand that have been referred to *humilis humilis.*

I was unaware that the species involved such a problem and as sometimes happens where the species is common, variable in coloration and tiny, the proper field notes were not always taken. The necessity for a complete review of this species from Mexico to Panamá is indicated.

*Anolis humilis marsupialis** subsp. nov.

(Fig. 23)

Type: KUMNH No. 40893, collected about 15 km. WSW of San Isidro del General along the Dominical Road, July 14, 1954; Edward H. Taylor, Coll. (Probably in Puntarenas Province, or near the boundary of this province in San José Province.)

Paratypes: KUMNH Nos. 40889-40892; 40894-40896, same data.

Diagnosis: Similar to *humilis humilis* but larger (to 44 mm.); the enlarged dorsal scales in ten to fourteen rows, the two median rows elevated into a suggestion of a dorsal crest and continuous with a similar nuchal crest, and larger than adjoining scalerows; dorsal scales about equal to or a little larger than ventral scales; axillary pocket much enlarged, the opening nearly as great as its depth, the side walls usually partly scaled; ventrals keeled.

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* From Greek word marsipion or Latin, *marsupium* = pouch bag, in reference to the axillary pouches.

Description of subspecies: Rostral low, about five times as wide as high, bordered by two labials and seven small postrostral scales, separated from nasal scales bordering nostril by one scale; supraorbital semicircles well defined, the scales large, moderately elevated, terminating in frontal area, separated between orbits by three or four scalerows, anteriorly by four scales; the scales on the row bordering the semicircles much larger than other head scales, and equally as large as the scales composing the ridge; none or only

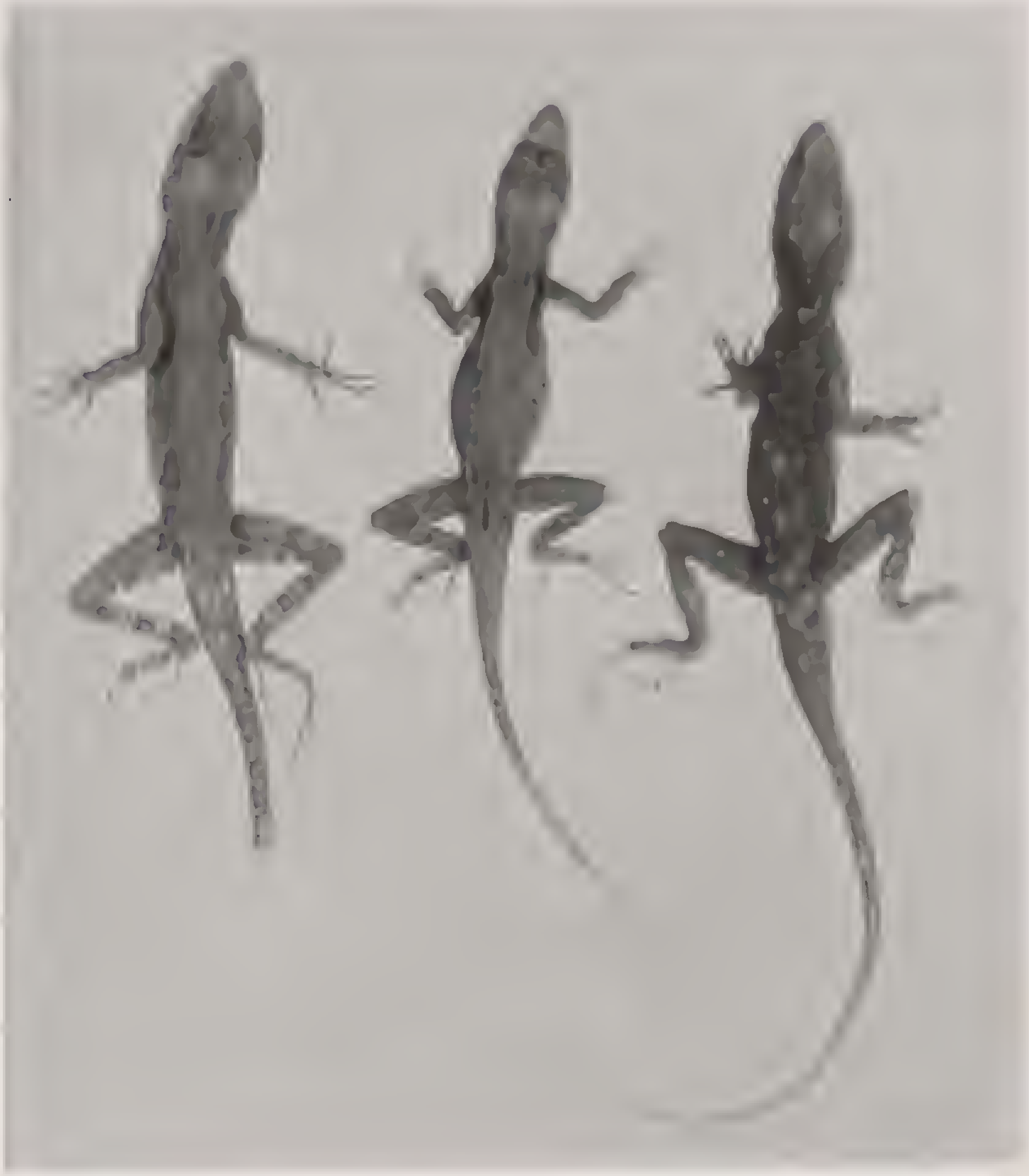

FIG. 23. *Anolis humilis marsupialis* subsp. nov. Left figure, KUMNH No. 40889♀, actual length, snout to vent, 46 mm.; middle figure, 40892♀, actual length, snout to vent, 38 mm.; right figure, 40893♂, type, actual length, snout to vent, 43 mm., tail, 68.2. All, 15 km. WSW San Isidro del General, (probably) in Puntarenas Province, C. R.

a vague occipital depression; a well-defined but shallow frontal depression; two elongate supraciliaries reach back of level of the middle of eye and are continuous with the canthal edge, which consists of four large scales; supraoculars in two rows, the inner the larger, separated from the supraorbital ridges by a row of small scales; most dorsal head scales with one or (more usually) three keels or ridges, the outer ridges formed by the upturned edges of the scale; six scales between dorsal nasal scales; occipital scale a half (or more) larger than adjoining scales, separated from the semicircles by three scalerows; about six loreal scalerows; a row of enlarged suboculars separated from the labials by a row of scales; nine or ten supralabials and about the same number of infralabials; back part of mouth bordered by granules; mental border on mouth very slightly larger than the rostral border, the scale three-fourths divided by a median groove, and bordered behind by eight scales, none especially enlarged; five scalerows below infralabials somewhat larger than other chin scales; a well-developed dewlap extending onto breast; about eleven or twelve rows of enlarged keeled dorsal scales, the two median largest and not in a groove but somewhat elevated above other dorsal scales; lateral scales keeled, the keels pointing upwards and backwards; ventral scales enlarged, the largest equal to or at most slightly less than dorsals; scales and granules around body about 82 of which about 23 are to be regarded as enlarged ventrals; scales on upper part of arm, front of forearm, on front face of femur, and around tibia, as large as dorsal scales, the keels forming straight lines directed outward from body; a postanal groove but no enlarged postanals. Fingers and toes very moderately widened with twelve or thirteen subdigital lamellae under widened part of the two longest fingers, and eight scales under the distal segment; nineteen lamellae under wide part of fourth toe, with nine scales under the distal section; scales on tail larger than dorsals, the single row of median dorsals slightly serrate; about thirty tail segments all somewhat compressed except at base of tail; height of tympanum equal to about three fifths of eye-opening; opening of the axillary pouch about as large as eye-opening, and about equal to its own depth; head longer than tibia.

Color in life: Above generally dark olive brown with a vague suggestion of lighter transverse markings between somewhat darker areas; belly light brown with some metallic reflections; dewlap dark reddish with a yellow border.

Measurements in mm.: (Nos. 40893 and 40889): Snout to vent, 43, 45; tail, 68.2, —; total length, 110.7, —; head length, 13, 14.9; head width, 7.3, 7.6; snout to ear, 12.2, 12.5; snout to arm insertion, 19.2, 21; axilla to groin, 18, 18.8; arm, 17.5, 19.2; leg, 34, 36; tibia, 11.5, 12.

Remarks: Variation in the small series is not great. It is presumed that the form may intergrade in the Pacific lowlands in Panamá with the more typical *humilis humilis*. If this is not proved it may be necessary to regard it as a distinct though related species.

Anolis lemurinus lemurinus Cope

(Figs. 24, 25, 26)

Anolis (Gastrotropis) lemurinus Cope, Proc. Acad. Nat. Sci. Philadelphia, 1861, p. 213 (type locality Veragua, New Granada [= Veragua, Panamá] Barbour, *loc. cit.*, suggests Cucuyos as probable locality).

Anolis lemurinus Boulenger, Catalogue of the lizards in the British Museum, 2nd Ed., vol. 2, 1885, pp. 86, 87; Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Oct. 1885, p. 52; Schmidt, Smithson. Misc. Coll., vol. 89, Mar. 16, 1933, p. 8 (Mt. Pirri, Darien); Barbour, Bull. Mus. Comp. Zool., vol. 77, no. 4, June, 1934, p. 137 (*Anolis (Dracontura) vittigerus* Cope, and *Anolis palpebrosus* Peters, *Anolis frontatus* Thominot, *Anolis biporcatus* Peracca (*part.*), *Anolis binotatus* Barbour, (*part.*) in synonymy).

Anolis lemurinus lemurinus Stuart, Misc. Publ. Mus. Zool. Univ. Michigan no. 91, June 6, 1955, pp. 18-19.

Anolis biporcatus Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Oct. 1885, p. 52, (*part.*).

Diagnosis: A medium-sized *Anolis* with the anterior scales of the semicircles much enlarged, the series separated mesially by one row of scales, or occasionally they may be in contact at narrow points; dewlap small, indicated also in females; no enlarged postanals; no axillary pockets; mental divided by a groove; one or no suboculars touch labials. Twenty median dorsal scalerows slightly enlarged but smaller than ventrals; approximately 160 scales and granules in a row around body; supraoculars in about four irregular rows, the two median largest, keeled; tail subcircular or slightly compressed distally; a series of large blackish or brownish marks along dorsum, or a broad median golden stripe from occiput to tail (present in some females); rarely diamond-shaped marks are present; roughness of head scales variable.

Description of species (From KUMNH 34270, Turrialba, C. R.): Rostral three times as wide as high, bordered behind by two labials and seven postrostrals; one scale between rostral and nasal; six scales between nasals; the semicircles consist of seven to nine scales one of which, lying anteriorly is 2½ mm. long, and separated from its fellow by two to four scale rows; the series separated mesially

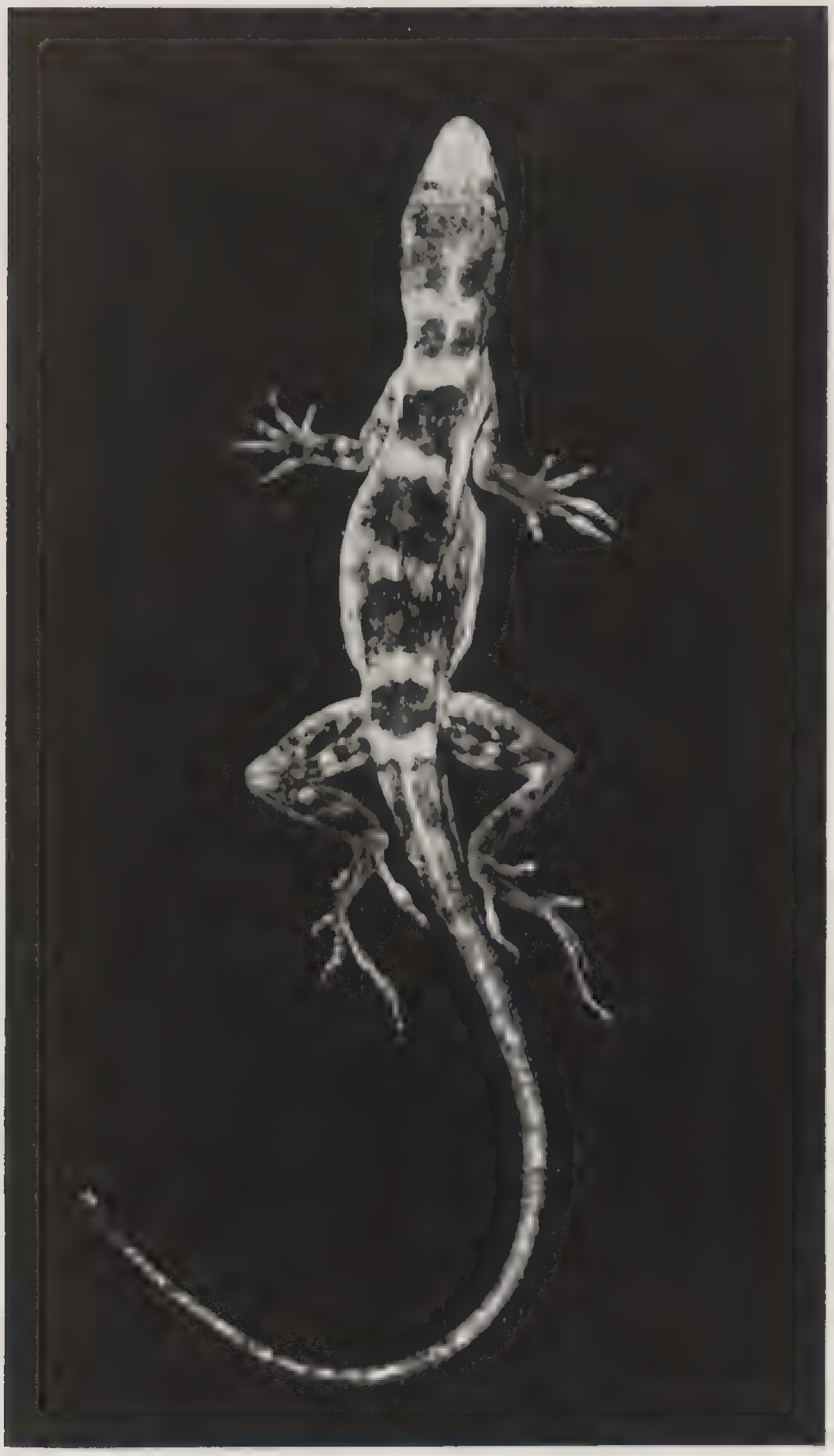

Fig. 24. *Anolis lemurinus lemurinus* Cope, KUMNH No. 34270; Turrialba, Cartago Province, C. R.; actual length, snout to vent, 63.5 mm.; total length, 165.5 mm.

by one scalerow; occipital scale irregular, larger than ear-opening, separated from semicircles by three or four scale series; supraoculars in four series the two median largest, somewhat keeled or roughened, the inner row separated, at least partially, from the semicircles by a row of granules; frontal depression very shallow; scales on snout lightly keeled; four or five canthals, each with a sharp keel; two small longitudinal rows of temporals; one much-enlarged supraciliary almost completely overlapping the second (posterior) one; six loreal series; six supralabials to below middle of eye; five or six infralabials to same point; six or seven enlarged suboculars the largest alone touching the labial series; three or four series of scales lying along infralabials somewhat enlarged; mental three-fourths divided by a groove, bordered behind by two labials and six postmentals, the outer pair enlarged; much-enlarged scales on each side of dewlap; scales of posterior occipital region very minute; about twenty enlarged dorsals, the four median a little larger than others; 72 scales on median line between level of axilla and groin; lateral granules small with a few scattered, slightly enlarged scales low on side near groin; ventrals subround, usually pointed slightly, distinctly keeled; dorsal caudal row much enlarged at base, keeled, but not serrate; two ventral series enlarged; all caudal scales keeled; (no enlarged postanals in males); digits widened; 28 scales and lamellae under the third and fourth fingers; 38 under fourth toe; scales on front and dorsal part of upper arm, on upper surface of forearm, on front of thigh, and ventral surface of tibia much enlarged, equal to or larger than the ventrals, all keeled; head longer than tibia; leg reaches eye; arm fails to reach groin.

Color in life (at night): Pinkish gray with large blackish quadrangular blotches with somewhat grayish centers on dorsum; sides gray; pinkish-white below on venter, under tail, and limbs.

Measurements in mm.: Snout to vent, 63.5; tail broken, partly regenerated, 102; snout to ear, 16; snout to leg insertion, 24.2; axilla to groin, 28; length of head, 18.3; width of head, 11; arm, 26; leg, 46.

Variation: The specimens having the dorsal black blotches are of both sexes and are from the following localities: Limón Province: KUMNH Nos. 40583-40584 Sipurio. Cartago Province: 34269, 34270 Turrialba; 34275 Tunnel Camp, near Peralta; Guanacaste Province: 34271, Las Flores, Tenorio, Las Cañas; 4 to 5 km. ENE Tilarán. Specimens having the dorsal stripe are all females. Car-

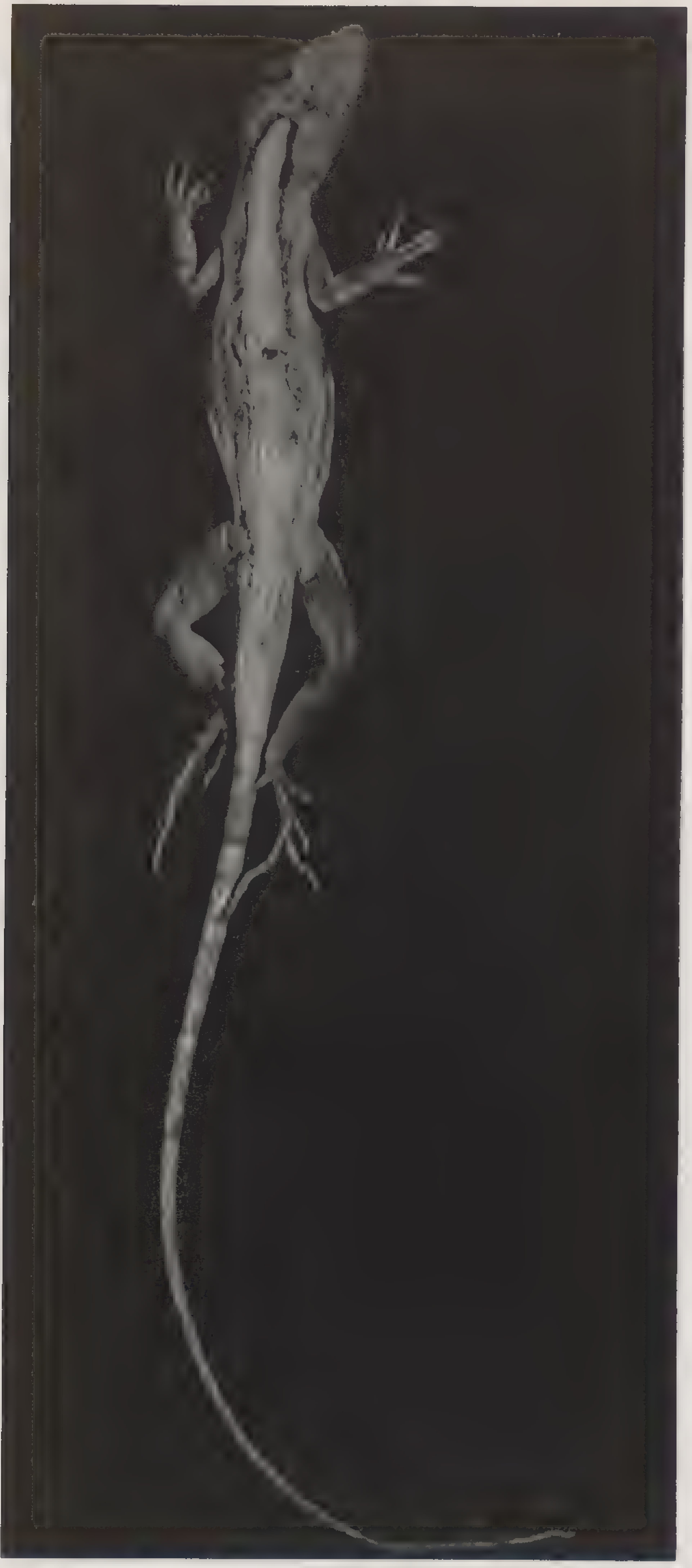

FIG. 25. *Anolis lemurinus lemurinus* Cope. KUMNH No. 34273♀; Golfito C. R.; actual length, snout to vent, 60 mm.; tail 125 mm.

tago Province: No. 34269, Morehouse Finca. Puntarenas Province: 34272-34274, Golfito.

The specimen from Sipurio, No. 40583 ♂, differs in having the dorsal blotches rather dim and series of small orange spots forming dorsolateral rows, with small orange spots on thighs and near base of tail. The dewlap has a depth of about 7 mm.; in preservative it is reddish orange in color on outer parts, the basal part white, the scales stippled with black. There are no enlarged postanal scales.

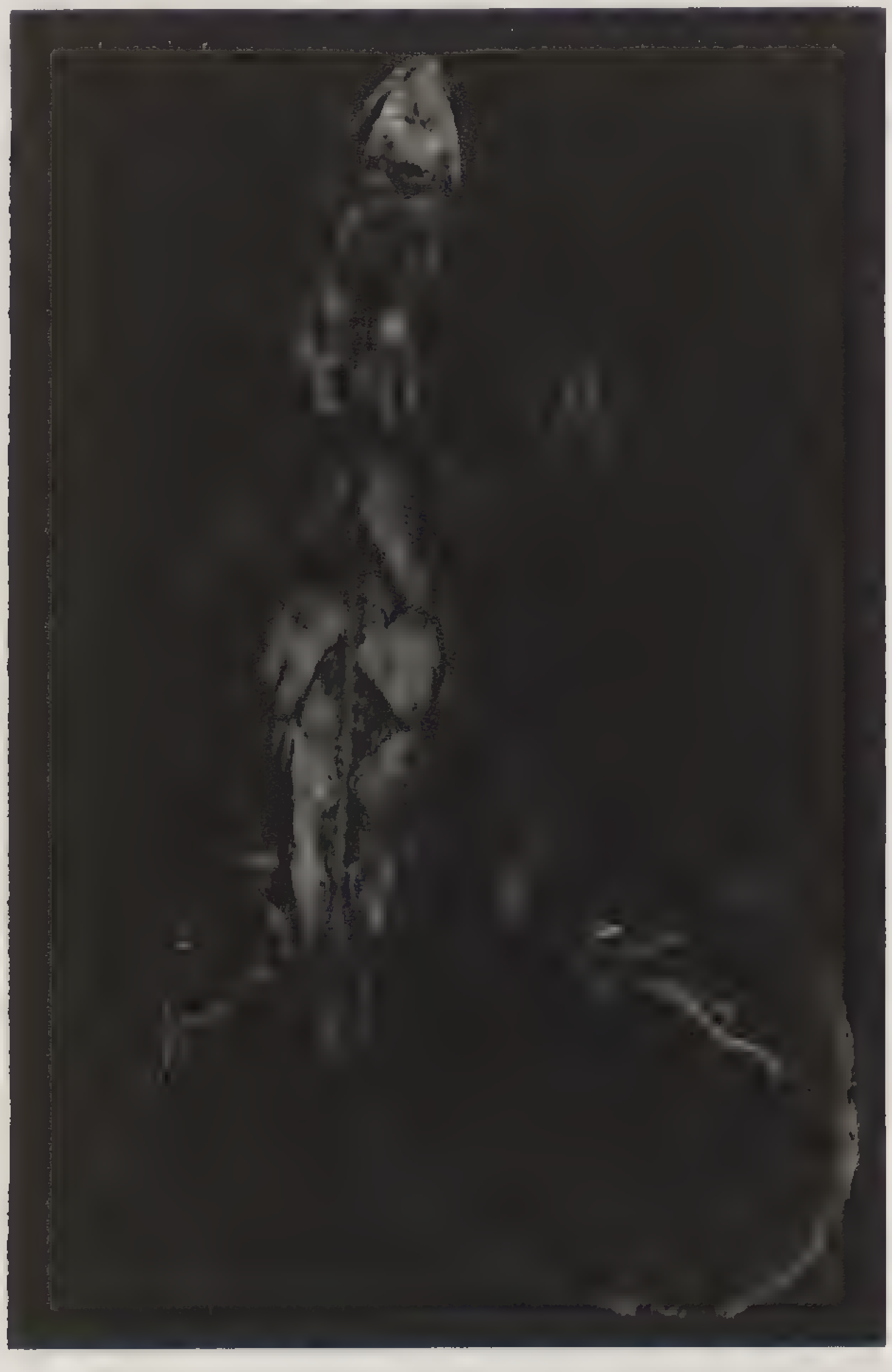

Fig. 26. *Anolis lemurinus lemurinus* Cope. KUMNH No. 40585, 4-5 km. ENE Tilarán, Guanacaste Province, C. R.; actual length, snout to vent, 59.2 mm.; tail, 97 mm.

In life the specimen was olive with slight yellowish wash, the frontal area and snout brownish. A light indistinct band was present across the head involving the front part of the upper eyelid. The axilla was dull yellowish. A distinct dorsolateral row of light orange spots were present. The scales on the side of the dewlap were pure white in life.

A second specimen taken from the stomach of *Anolis biporcatus* that was captured on Mt. Mirador near Suretka, showed the dorsal surface of head and body with bright varied metallic iridescence. On the head there are numerous small black spots; the occipital area is almost solid black and there is a black line from the eye meeting its fellow on the anterior nuchal region. The venter and throat are light with greenish or bluish metallic reflections. However there are a few blackish flecks on the chin and a brown spot on the belly. The dewlap is red, the temporal area copper-colored.

The females from Golfito are generally greenish gray on the sides of the head and body. A broad golden band begins just posterior to the occipital scale, widens and continues onto tail where it is gradually lost; it is bordered by narrow indefinite brownish lines. The banding on the tail is not distinct. There is a large brownish blotch in the middle of the belly extending onto the sides.

A female from the Morehouse Finca, Turrialba has a broad golden stripe, the edges sinuous and forming at intervals four lateral angles. The head and the sides of the neck are deep brown; No. 34273 has a dim hair-fine median golden line bordered by narrow black stripes. The venter is uniform light. The stippling on the scales is scarcely discernible under a lens. There is some difference in the rugosity of the head scales; the semicircle scales in some specimens continue on behind the eye; in others the number is reduced and they are not distinguishable back of the eye.

The Golfito specimen (No. 34272) measured 58 mm. snout to vent. The tail, complete, is 123 mm. in length, thus more than twice the head-body length.

Remarks: These animals are rather slow moving. Some have been taken at night seemingly asleep at the outer tip of small branches. The female from near Turrialba has three ovarian eggs, two much larger than the third.

A specimen KUMNH 40505 from 4.5 km. ENE of Tilarán, Guanacaste Province, is gray with diamond-shaped blackish marks (figured).

Anolis intermedius Peters

(Figs. 27, 28)

Anolis intermedius Peters, Monatsb. Akad. Wiss. Berlin, 1863, p. 143 (type locality, Veragua, Panamá); Bocourt, Mission Scientifique au Mexique et dans l'Amérique Centrale; Études sur les reptiles, livr. 2, 1873, pp. 69-71, pl. 15, fig. 4, (redescription of the type); Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1876 (1875), p. 124 (Costa Rica); Boulenger, Catalogue of the lizards in the British Museum, 2nd Ed. vol. 2, 1885, pp. 78-79 (*part.*) (places *nannodes* Cope, and *tessellatus* O'Shaughnessy in synonymy); Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Oct. 1885, p. 49 (*part.*) (Irazú, Costa Rica); Cope, U. S. Nat. Mus. Bull. 32, 1887, p. 30, Proc. Amer. Philos. Soc. Dec. 23, 1893, p. 344 (San José C. R.); Boettger, Ber. Senck. Natur. Ges. Frankfort, 1894, p. 27; *idem, ibid,* 1895, p. 36 (San José. C. R.); Dunn, Proc. New England Zool. Club, vol. 12, 1936, p. 18 (Santa Rosa, Costa Rica); Wettstein, Sitzungsb, Akad. Wiss. Wien, Math-natur. Kl. Abt. 1, Band 143, Heft, 1-2, 1934, p. 21 (La Carpintera, C. R.); Barbour, Bull. Mus. Comp. Zool. Harvard Col., vol. 77, no. 4, 1935, p. 135 (San José).

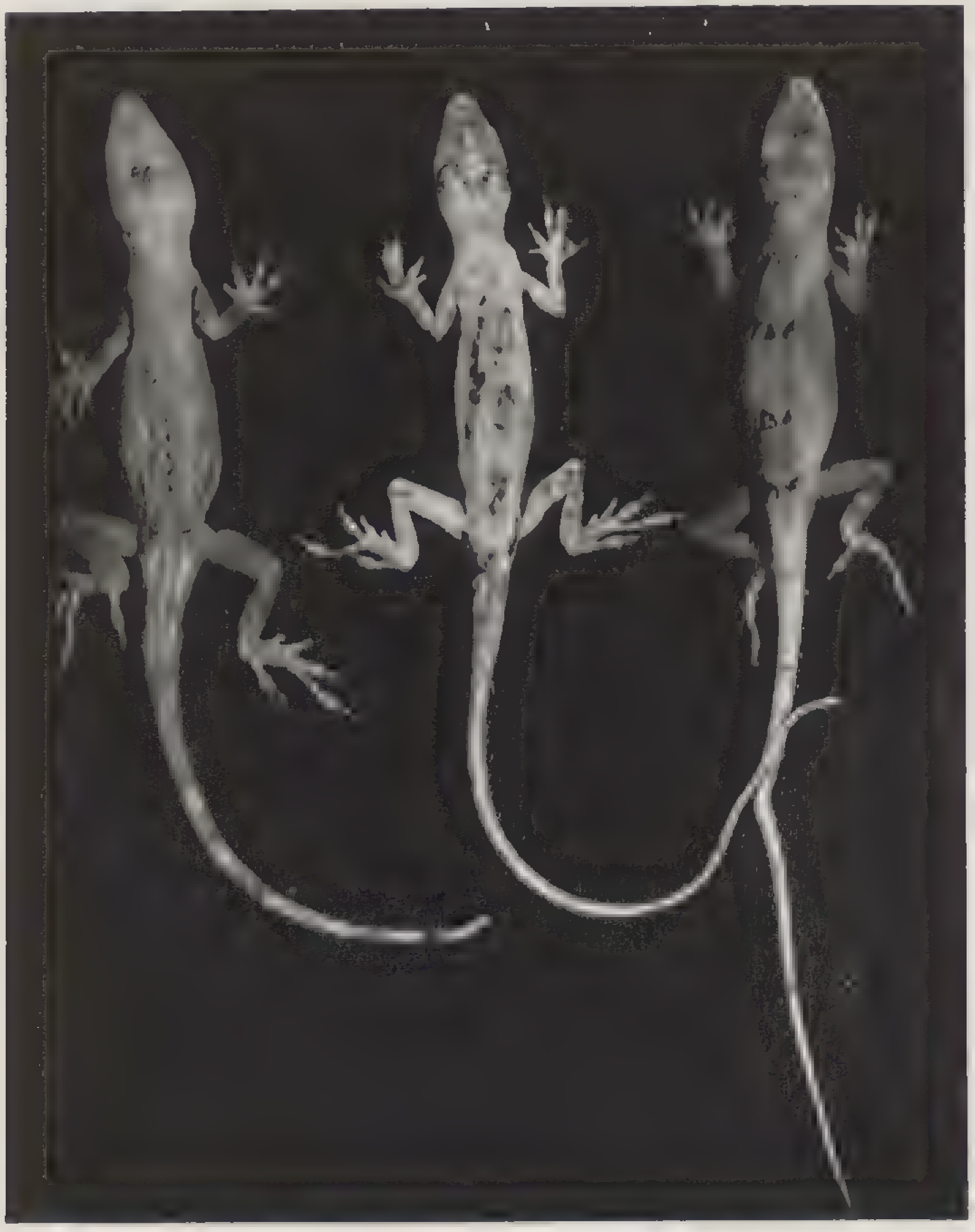

FIG. 27. *Anolis intermedius* Peters. Left figure, KUMNH No. 34283 ♀; length, snout to vent, 49 mm., Cartago, Cartago Province; middle figure, 34286 ♀, length, snout to vent, 47.3 mm.; right figure, 34284 ♀, length, snout to vent, 44 mm.; same loc.

Diagnosis: A medium-small species, the median semicircles composed of few large scales of which one, often two, are in contact on middle line; head scales slightly rugose or smooth; four rows of loreal scales; ventrals keeled, a little larger than median dorsals; three of subocular series bordering labials; occipital larger than ear; frontal depression scarcely discernible; four postmentals, the two outer enlarged; two longitudinal series of somewhat enlarged temporals; a row of somewhat enlarged postanals; hind leg reaches halfway between arm insertion and ear.

Description of species (From KUMNH No. 34283 Cartago, Cartago Prov. C. R.): Rostral about three times as wide as high, bordered behind by two labials and five postrostrals; four scales between tiny supranasals; three or four enlarged canthal scales; anterior smallest; the semicircular rows are not clearly distinguished; a pair of very large scales lies between the supraorbital areas completely in contact; these preceded by a pair of scales nearly as large but separated mesially by a single scale; these are separated from canthals by a single smaller scale; behind the central scales there are three of the semicircular series curving behind supraorbital area; occipital larger than the ear-opening, separated from semicircles by two scale series; behind occipital region two somewhat swollen areas each covered with rather large scales in three or four series but separated by granules from a double line of somewhat enlarged temporal scales; five scales across snout between first canthals; two irregular series of supraoculars, the inner three scales largest, separated from semicircles by a row of regular granules; four rows of loreal scales; four suboculars enlarged, three touching labials, only one scale between rostral and nasal; eight supralabials, the seventh below middle of eye; eight infralabials; mental larger and wider than rostral, divided by a groove, bordered behind by two labials and four postmentals, the outer enlarged; three scale series bordering the infralabials somewhat enlarged, one larger than others.

Ventral scales keeled, in about 26 rows, merging gradually to fine granules of sides; dorsolaterally scales become gradually larger, the dorsal fourteen rows nearly same size; however the median three or four are slightly largest but smaller than ventrals; (males with a slight nuchal fold or crest, and the median dorsal scales may be slightly elevated); a few scattered larger scales among granules on sides preceding groin; about 126 rows of scales and granules about middle of body; digits except first dilated, 13 widened lamellae and seven scales under third and fourth fingers; no axillary pocket; 33 lamellae and scales under fourth toe; hind leg very short reaching about halfway between arm insertion and ear; scales on upper side of upper arm, front of forearm, front face of thigh, and the back and under portion of tibia with large keeled scales equal or in places larger than ventrals. Tail nearly cylindrical at base, more compressed distally; the single median dorsal series not serrate.

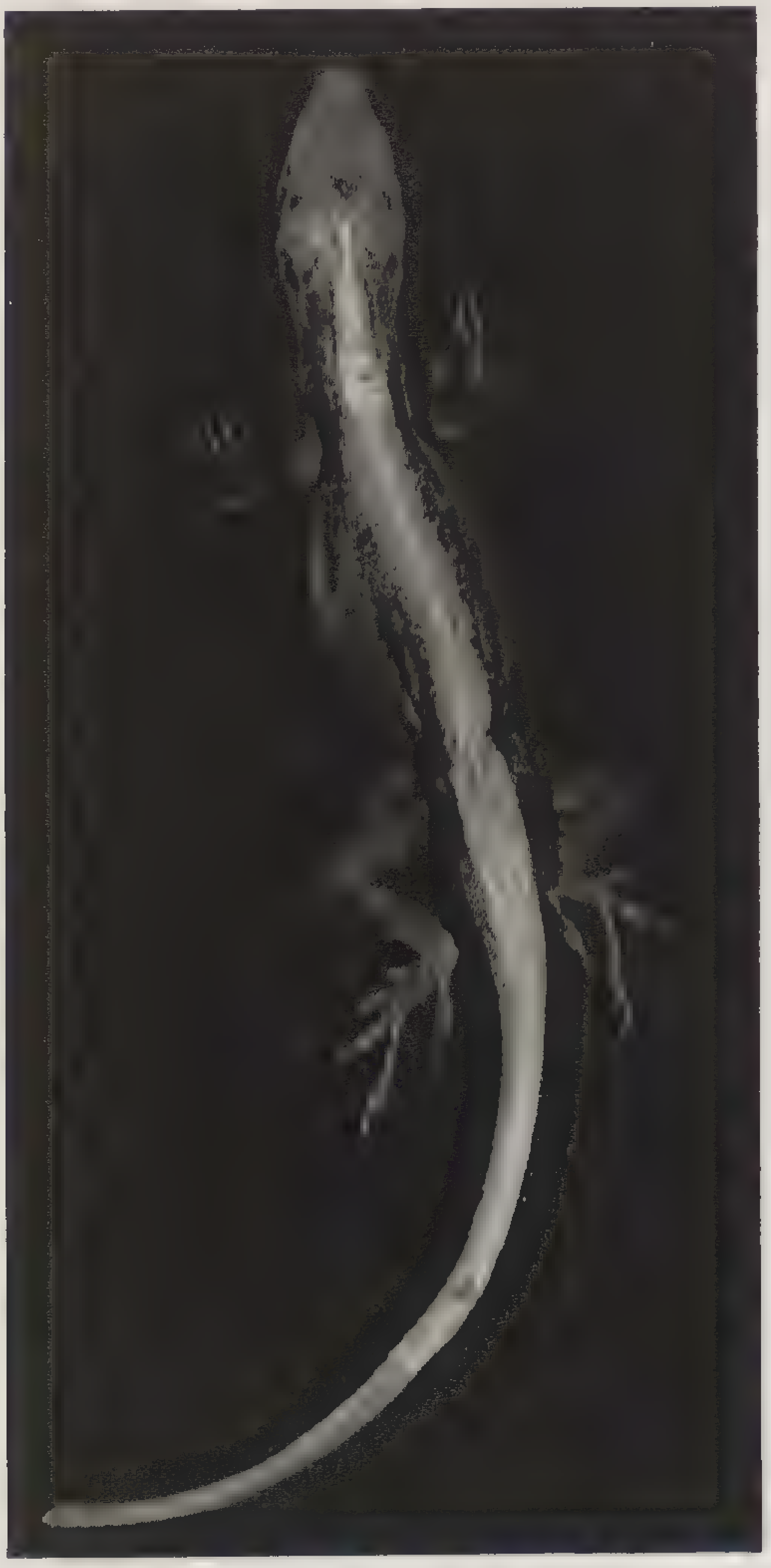

FIG. 28. *Anolis intermedius* Peters. KUM NH No. 34282, Cartago, Cartago Province, C. R.; actual length, snout to vent, 50.2 mm., tail (regen.), 62 mm.

Color in life: Very changeable. Darker median stripe covering about twelve scalerows bordered by a dim line of fawn on which are discernible four pairs of somewhat triangular brown spots, the last between hind limb insertions breaking continuity of fawn line; narrow brown line on head between eyes; occipital region blackish; a few silvery flecks on the scattered enlarged scales in region anterior to groin; tail banded in dirty fawn and brown, dirty whitish below, with some brownish flecks and minute black stippling; metallic reflection on belly and under limbs.

Measurements in mm.: Snout to vent, 48; tail broken and regen. 58; snout to arm insertion, 19; snout to ear, 14; axilla to groin, 23; length of head, 15; width of head, 8.4; arm, 18; leg, 29; tibia, 10.

Variation: The arrangement of the large scales on the head varies and scarcely any two specimens having the same exact arrangement can be found in my small series. In one other Cartago female (specimen No. 34284), there are seven scales in the semicircles, only one pair, between eyes is in contact. In this case however the large median pair is transversely segmented and a small median scale separates the anterior moieties; the scales on head are slightly more rugose; the supraoculars are fewer and larger, one or two touching the semicircles. The color pattern is practically the same as the preceding.

In a male from Cervantes, the head scales have shallow depressions giving the appearance of being very rugose; two large pairs of scales are in contact between eyes. There is a distinct nuchal fold or crest and an indistinct dorsal crest. The mental is followed by only two large postmentals. There are five or six enlarged postanal scales present. The dewlap is small, its depth probably not half as great as head length. There are seven or eight large supraoculars largely covering supraocular region.

A specimen from higher elevation in the National Forest agrees in color with the described specimen. In this, a male, the postanal scales are a little smaller; a female specimen 47 mm. long has a complete tail measuring 76 mm. This specimen is generally grayish with a faint rose wash and some blackish dorsal flecking or shading. The supraocular region is brownish and the interorbital and occipital area gray while the tip of the snout is darker; there is a faint lavender tinge on the white of the venter. The dewlap of males is usually white with sometimes a faint greenish or rosy wash.

Remarks: This species seems to persist after the removal of forest. They thrive in gardens in the cities, on hedges, or on fences with live posts. They seem to be curious and will perch on a branch of a shrub watching children playing close by. They are not much afraid and one may often approach them slowly and grasp them with little difficulty. The dewlap of the males may be distended as the animal remains otherwise quiet, within a few feet of the beholder. The appendage is small and not especially conspicuous.

Anolis cupreus Hallowell

(Fig. 29)

Anolis cupreus Hallowell, Proc. Acad. Nat. Sci. Philadelphia, 1860, pp. 481-482 (type locality, Nicaragua); Cope, Proc. Acad. Nat. Sci. Philadelphia, 1874, p. 68 (Nicaragua); Boulenger, Catalogue of the lizards in the British Museum, 2nd Ed., vol. 2, 1885, pp. 80-81 (Guatemala and "neighborhood of Irazu [Volcán], Costa Rica"; Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Oct. 1885, p. 50; Boettger, Katalog der Reptilien-Sammlung im Museum der Senckenbergischen Naturforschenden Gesellschaft in Frankfurt am Main, I Teil. Aug. 1893, p. 59 (San José); Dunn, Proc. New England Zool. Club, vol. 12, 1930, p. 17 (San José, Costa Rica); Schmidt, Field Mus. Publ. Zool., vol. 12, Nov. 21, 1928, p. 195 (El Salvador); Barbour, Bull. Mus. Comp. Zool., Harvard Col. vol. 77, no. 4, 1934, p. 129-130 (includes *hoffmani* Peters from Costa Rica); Stuart, Misc. Publ. Mus. Zool. Univ. Michigan, no. 91, June 6, 1955, pp. 15-16 (places *macrophallus* Werner in synonymy).

Anolis hoffmanni Peters, Monatsb. Akad. Wiss. Berlin, 1862 (1863?) p. 142 (Costa Rica); Bocourt, Mission Scientifique, au Mexique et dans l'Amérique Centrale; Études sur les reptiles, livr. 2, 1873, p. 86, pl. 15, figs. 15, 16; Cope, U. S. Nat. Mus. Bull. 32, 1887, p. 31 (Costa Rica and Guatemala).

Diagnosis: A diminutive species, (40-42 mm.) the median dorsals (fifteen to twenty rows) larger than lateral granules; four median rows largest, keeled, but much smaller than the ventral scales which are rhomboidal, imbricating, and distinctly keeled; gular appendage of male relatively very long longitudinally, extending to middle of belly, not or scarcely indicated in female; head slightly longer than tibia; no enlarged postanals; scales of supraorbital semicircles large, separated by one or two series of scales; occipital larger than ear-opening; six loreal rows.

Description of species (From KUMNH No. 40751 Las Flores, Tenorio, Las Cañas, Guanacaste Province, C. R.): Rostral about three times as wide as high, bordered by two labials and seven postrostrals; nine scales between nostrils; nasal a tiny ring about nostril separated from rostral by one scale; supraorbital semicircles well defined, not or scarcely elevated into ridges, each scale with one sharp keel and other sculpturing; scales on frontal area keeled, the edges of the scales somewhat elevated with some fine tuberculation; semicircles separated by one or two scale rows; two large supraoculars and four smaller ones, all keeled, the larger ones separated from the semicircles by a row of granules; occipital enlarged, nearly double size of ear-opening, surrounded by three series of scales with their edges elevated appearing to be tricarinate, and separated from the semicircles by three scales; two elongate supraciliaries, the anterior overlapping the posterior; back part of supraciliary edge without enlarged scales; canthus formed by three enlarged sharp-edged scales; six or seven supralabials and

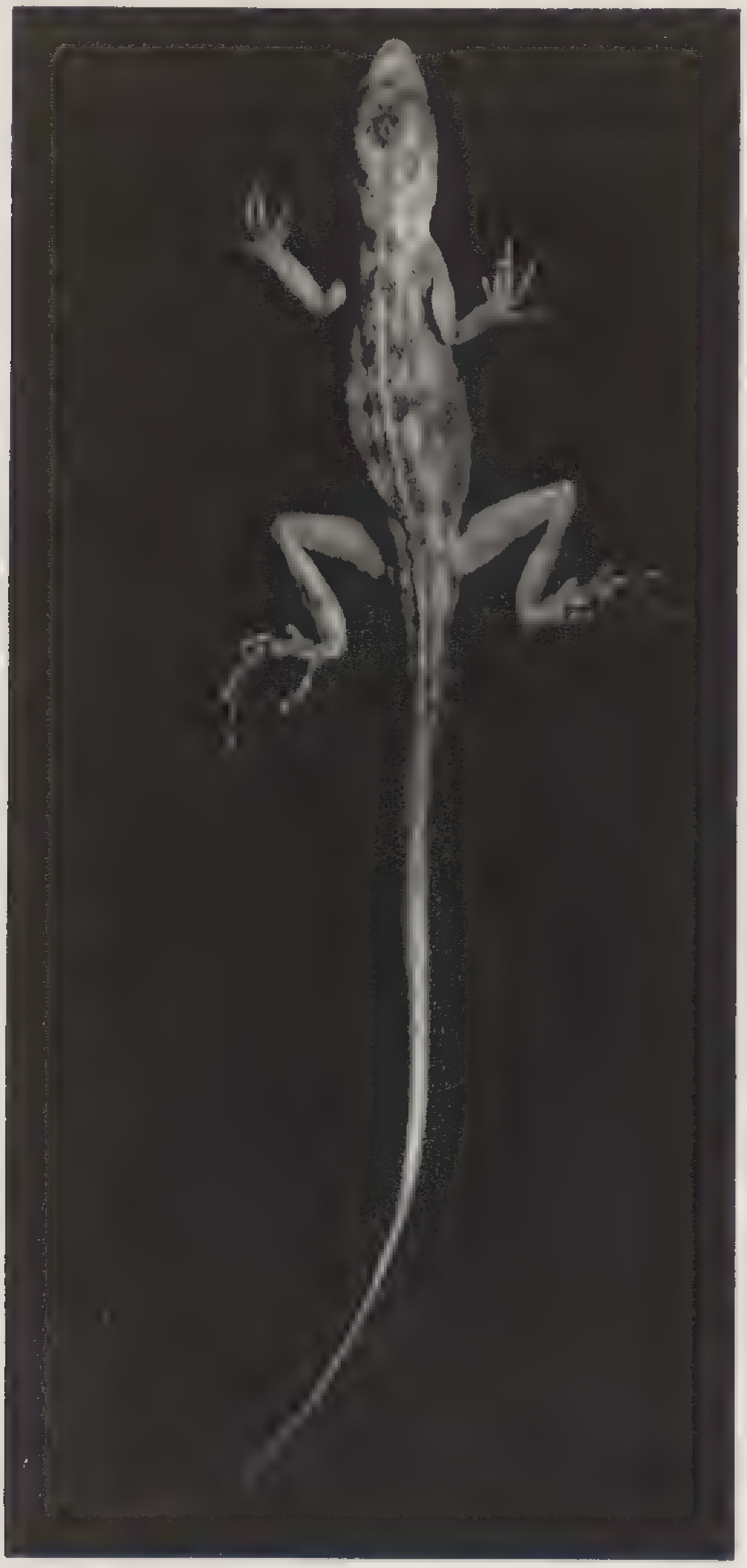

FIG. 29. *Anolis cupreus* Hallowell. KUM NH No. 40739, Maribella Hotel, mouth of Río Barranca, Puntarenas Province, C. R.: actual length, snout to vent, 41 mm.

seven or eight infralabials; seven loreal series; three or four enlarged suboculars separated from labials by one row of scales; five or six scalerows below infralabials somewhat larger than median series on chin; mental slightly wider than rostral, divided by a groove, the parts nearly triangular, about as wide as deep, followed by two infralabials and six keeled postrostrals; five median scalerows on back larger than others, the edges being upturned they appear tricarinate; they are polygonal, chiefly pentagonal; the next eight or ten rows gradually merge into the small lateral granules; low on sides the keeled granules gradually enlarge; ventrals much larger than the dorsals, with a single keel, imbricating and somewhat rounded posteriorly; a faint trace of a dewlap in female represented by a slight fold on neck; about 125 scales and granules in a row about the middle of body; caudal scales hexagonal, large, keeled, the median dorsal row enlarged as are the two ventral rows; tail thickened at base, slightly compressed to tip; about ten pointed scales bordering vent anteriorly; (no enlarged postanal scales in males); arm short not reaching more than halfway between eye and nostril; leg reaches eye; digits widened somewhat; 16 lamellae and scales under the fourth finger; about 19 widened lamellae under fourth toe (distal joints of both fourth toes incomplete and scales not counted); enlarged scales on dorsal part of upper arm, front face of forearm, front face of thigh and ventral part of tibia, some about the size of ventrals; ear-opening small, 1.1 mm. x .7 mm.; head longer than tibia.

Color: A median cream line covering two scalerows; this bordered laterally by a grayish stripe of varying width bordered on both sides by brown, the outer edge sinuous or forming angles at intervals; head nearly uniform olive-brown; a faint brown mark begins behind eye and runs back across temporal region; below light on chin and venter.

Measurements in mm.: Snout to vent, 41; tail, 71; snout to ear, 10.5; snout to leg insertion, 17.3; axilla to groin, 17; length of head, 12.2; width of head, 6.8; arm, 15.5; leg, 29.5; tibia 9.3.

Variation: Specimens in the collections are from the following localities: Guanacaste Province: KUMNH Nos. 40743, 40752-40763, 4 to 5 km. ENE Tilarán; 40747-40751 Las Flores, Tenorio, Las Cañas. San José Province: 40741 San José; 5-10 km. E Sarchi. Puntarenas Province: 40739, 40740, 40742 Maribella Hotel, mouth of Río Barranca.

Males have a gular dewlap which is elongate, extending back to the middle of the belly. The color varies from cerise to magenta, enclosing an area of orange or of orange mixed with black.

The body of males appears more compressed. Often the median part of dorsum bears an indefinite dark stripe. One or two of the specimens have a dim brown spot on the shoulder. The female specimen figured has a yellow median line and dim paired black spots in preservative.

Remarks: This species, which somewhat resembles *limifrons* in size and behavior, was taken only on the Pacific slopes of the country. Specimens were seen most frequently in high grass which was their permanent dwelling. I have not found the species in typical forest.

[*Anolis* sp.]

(Fig. 30)

A specimen KUMNH No. 10649 from near Esparta, Puntarenas Province, differs from the typical *cupreus* in being significantly larger (49 mm. snout to vent, the tail regenerated); six median scalerows enlarged, smaller than ventral scales; postanals enlarged; about 132 scales and granules around body; occipital much larger than ear-opening; semicircles separated by one scalerow; suborbital elongate and except for last, separated from labials; six loreal series; posterior supraciliaries small; dewlap attachment elongated to middle of abdomen, as in typical *cupreus*.

The color is olive green with a large black shoulder spot followed by three other lateral spots less strongly distinguished. Whether this specimen represents a distinct species, a subspecies of *cupreus*, or is only an aberrant specimen of *cupreus* cannot be decided now.

Anolis altae Dunn

Anolis altae Dunn, Proc. New England. Zool. Club., vol. 12, Aug. 7, 1930, pp. 22-23 (type locality, Acosta Farm, about 7000 ft. elev. Volcán Barba, Costa Rica).

Diagnosis: An *Anolis* with keeled ventrals; dorsals much smaller than ventrals, granular to keeled, gradually enlarged to middorsal region, but none much so; two scales between semicircles; tail cylindrical with even large keeled scales.

Description of type: "Two faint frontal ridges diverging, and two fainter prefrontal ridges converging; head scales unicarinate or flat to concave; rostral low and wide, lower than mental; semicircles separated by two scales; occipital larger than ear, separated from semicircles by two scales; supraocular disks of three large

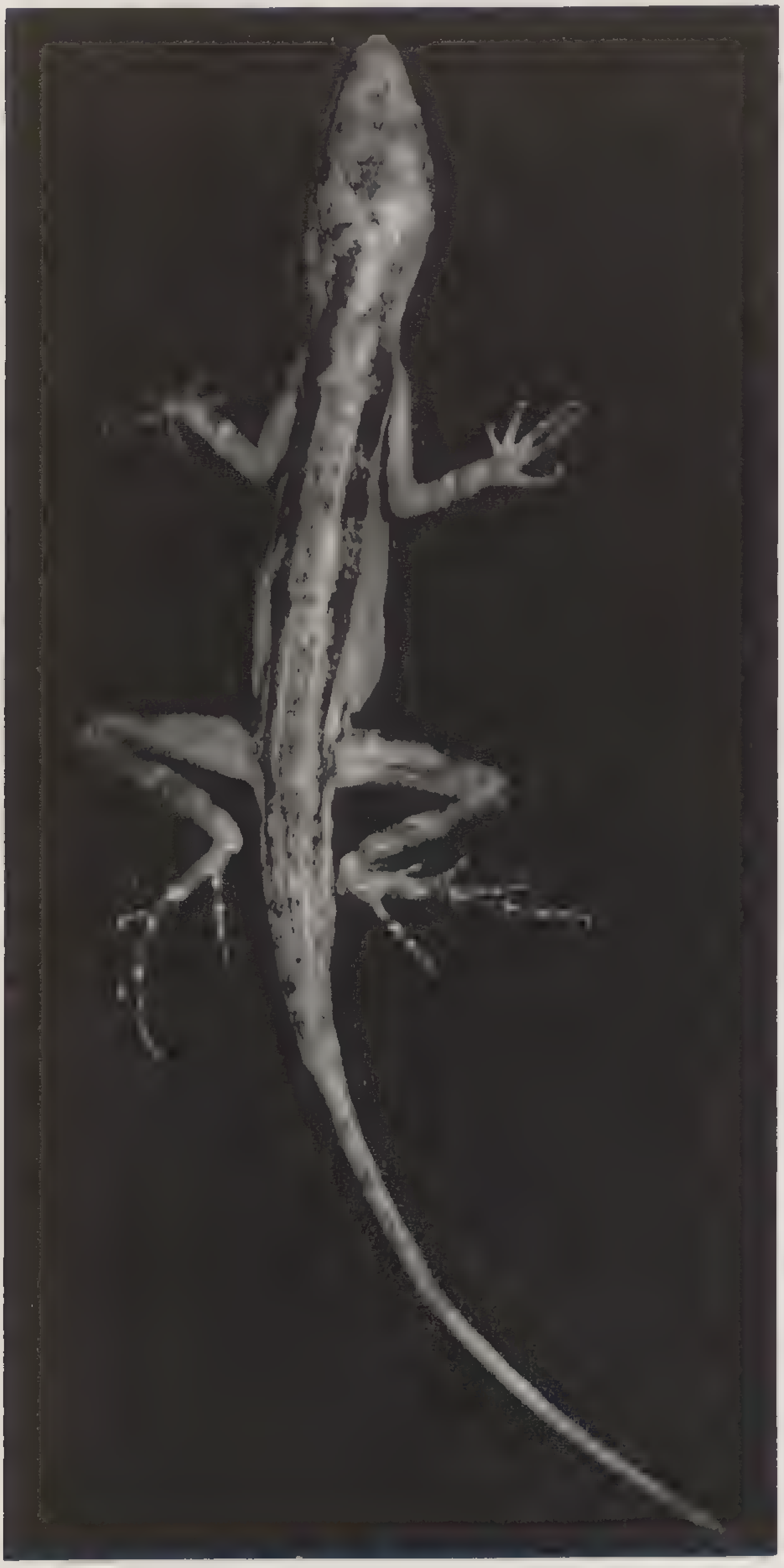

FIG. 30. *Anolis* sp.? KUMNH No. 40632, 6 mi. E Esparta (on cliff along highway), Puntarenas Province, C. R.; actual length, snout to vent, 49 mm.

scales and smaller ones, flattish and unicarinate, in contact with semicircles; canthus rostralis evident only for a short distance just anterior to eye; three angulate scales, in front of which is a unicarinate scale, the most anterior of the semicircles; the posterior is on the eyelid; posterior edge and half of eyelid granular; six rows of loreal scales; six supralabials; temporals granular; fingers and toes not much dilated; sixteen lamellae under phalanges I and II of toe IV; tail almost cylindrical, scales large, imbricate and unicarinate; ventrals much larger than dorsals, keeled; dorsals gradually increasing to last row, which is keeled but not much enlarged.

Color: "Brown, a broad (16 scale wide) tan dorsal band; whitish below. Dewlap not noticeable (a female)."

Measurements in mm.: "Total length, 142; head and body 52; tail, 90."

Remarks: Dunn regards this species as being closest to *concolor.*

Anolis woodi woodi Dunn

(Fig. 31)

Anolis woodi Dunn, Proc. Acad. Nat. Sci. Philadelphia, vol. 92, 1940, pp. 110-111 (type locality, El Volcán, Chiriquí, Panamá).

Diagnosis: Rather large form, 72+ mm. snout to vent; ear-opening four fifths of the length of eye-opening; suboculars separated by one scalerow from the supralabials; a large shallow axillary depression, scaled and pigmented; a slight nuchal fold or crest, and a slight median dorsal ridge; the 20 median scalerows larger than laterals; dorsal scales distinctly smaller than ventrals, which are keeled and strongly imbricating, rather oval in posterior outline, the tips slightly elevated; postanals distinctly enlarged; supraorbital semicircle consisting of elevated enlarged scales, separated by two or three scalerows; the canthal scales and those bordering them have from two to five fine keels or ridges directed outward and backward; occipital scale, flanked by two enlarged scales, is less than half size of ear-opening; tail 2.3 times length of head and body.

Description of species (KUMNH 40633, 1 mi. W Cañas Gordas, Puntarenas Province): Greatest total length known, 235 mm. Rostral nearly four times as wide as high, bordered behind by eight rough postrostral scales and two labials; separated from nasal by one scale; eight scales between nasals, with high ridged keels; supraciliary scales overlapping the larger ones beginning behind the middle of eye, extending forward, and joining the canthal series; latter with sharp canthal edge extending to below nostril, about six scales in the series, the anterior ones small; seven loreal

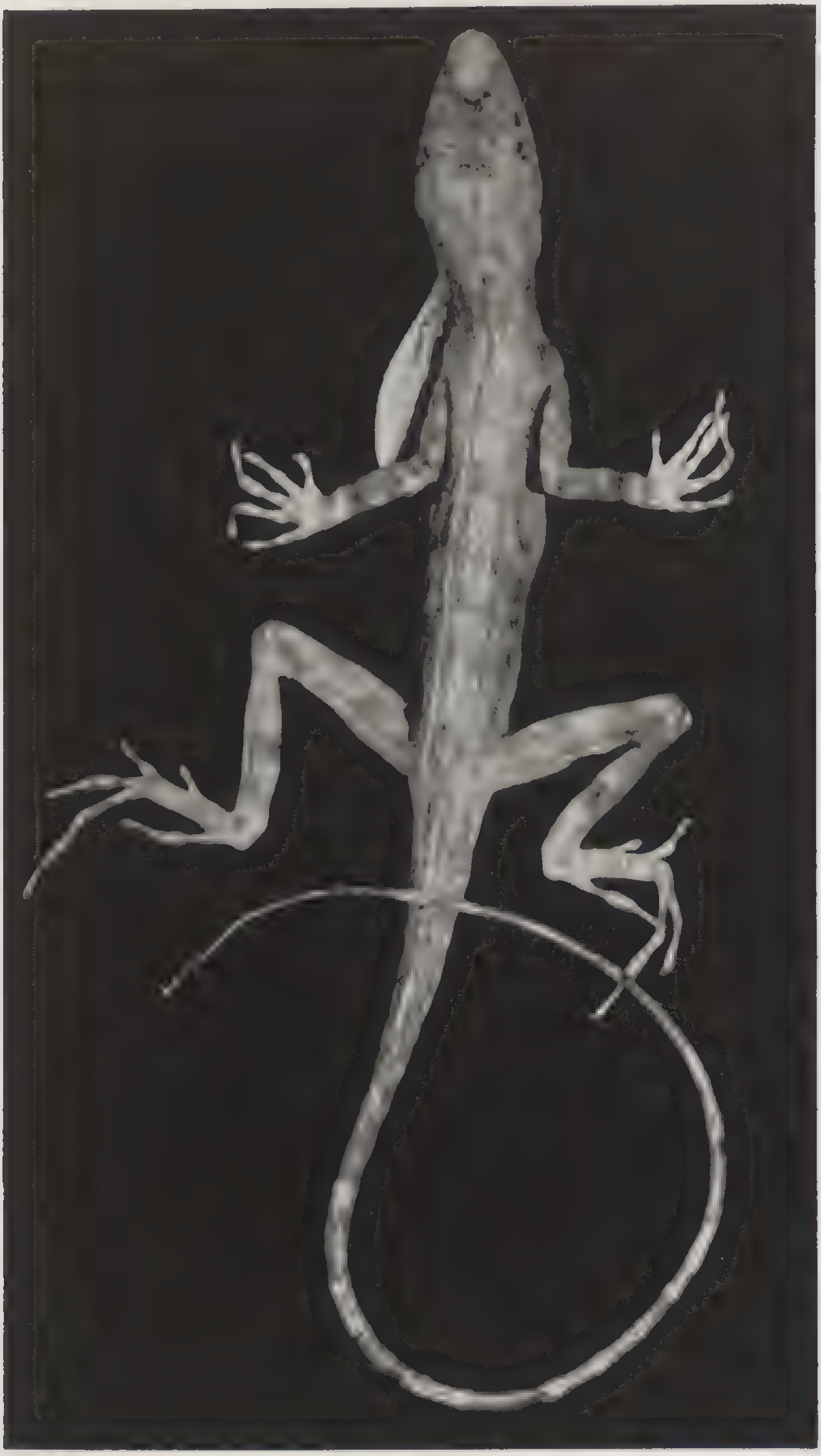

FIG. 31. *Anolis woodi woodi* Dunn. KUMNH No. 40633, Cañas Gordas, Puntarenas Province, C. R.; actual length, snout to vent, 71 mm., tail, 164 mm.

series; supraorbital semicircles composed of large scales somewhat elevated, each with two to five fine brown keels or ridges directed variously, the series separated by three rows (the median of which may be interrupted); a shallow frontal depression floored with rather large scales; supraocular region with about four rows of enlarged keeled scales, the inner series largest, the outer little larger than the granules of outer part; largest series separated from the semicircles; occipital distinct, pointed behind, flanked by two much-enlarged scales; the occipital separated from semicircles by four rows of scales; eleven or twelve supralabials, the ninth below middle of eye; seven or eight rather large suboculars separated from the supralabials by an intercalated series of smaller scales; mental wider than rostral, about three times as wide as high with two short posterior projections and a groove that divides it for more than two thirds of its height, bordered behind by a large outer multiple-ridged scale and three smaller ones, as well as by two labials; eleven or twelve infralabials, the posterior part of the mouth bordered by small granules; five or six rows below infralabials somewhat enlarged; occipital area with several rows of scales bordering occipital, all somewhat enlarged; granules behind these smaller than those on dorsal part of body; about 125 scales around middle of body; a very slightly elevated nuchal crest, more or less continuous with a discernible dorsal crest (in males) which continues onto tail; body distinctly triangular in cross-section; tail triangular at base, distally compressed; dorsal caudal scales enlarged, not or but slightly serrate; caudal scales in whorls; tail ends in a slightly widened black tip.

Ventral scales much larger than dorsal (dorsals, eleven in 5 mm. distance, ventrals, eight in same distance); granules on side small, the twenty dorsal rows considerably larger than laterals; dorsals, laterals, and ventrals keeled or ridged; postanal groove deep, arched, with a single median and two lateral scales, all distinctly enlarged; paired subcaudals larger than adjoining scales.

Dewlap large, extending back of level of axillae for seven millimeters; its greatest length (depth) about equal to head length; length of tibia equal to head length.

Arm brought forward the fingers reach snout tip; seventeen lamellae under widened part of the two middle fingers; a large distinct depression in axillary region, not forming a typical pocket. Leg extended, the fourth toe reaches to a little in front of orbit. Twenty-four scales under widened part of fourth toe and ten on distal phalanx making a total of 34. Tail 2.3 times snout-vent length.

Color in life: Generally olive with some indistinct rusty spots; tail rusty brown, indistinctly barred with olive; venter olive with much rusty brown in evidence; leg olive, narrowly barred with rusty brown; eyelids with a brown band, and several fine transverse lines; a dark area in occiput and some radiating brown bands below eye; a dark light-edged nuchal spot.

Dewlap (throat fan) large, pink-orange on edge, then a band of amber-yellow, while at base an area of bluish-white; many scales on sides of dewlap whitish. Chin pinkish; rusty orange spots under base of tail; lips lighter than sides of head. The characteristic markings of the preserved specimens are indicated in the figure given.

Measurements in mm.: Snout to vent, 71; tail, 164; total length, 235; snout to ear, 174; snout to arm insertion, 28.5; length of head, 20; width of head, 12; height of tympanum, 2.3; arm, 33; leg, 58; tibia, 20; axilla to groin, 30.

Remarks: This specimen was the only one of this species that was seen. It was caught on a low bush in the daytime.

The female type is the only other specimen that has been reported. The type description is somewhat inadequate and some important data are omitted. Dunn suggests that the color and size is similar to *Anolis capito* and perhaps they may be related. Such relationship is indeed remote and no pertinent similarities are in evidence.

The size of the type female is only two millimeters larger than the male here described, one millimeter in snout-vent length, and one in tail length.

The specimen differs markedly in coloration, as there is no trace of the white lobulate dorsal band occurring in the female, and the number of scales and lamellae under the fourth toe is greater (34 instead of 29).

Anolis woodi attenuatus * subsp. nov.

(Fig. 32)

Type: KUMNH No. 34257, collected at Isla Bonita (American Cinchona Plantation) southeastern slope Volcán Poás, elev. circa 5,500 ft., July 29, 1947, Edward H. Taylor, coll.

Paratypes: Richard C. Taylor, No. 668 and KUMNH No. 34256, topotypes.

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* From Latin *attenuatus* = drawn out, tapered, in reference to the greatly elongated tail.

Diagnosis: A medium-large species 78-83 mm. snout to vent; the tail 183-201 mm.; mental about 2/3 divided with smaller labial border than rostral; six scales (beside labials) border rostral; a pair of semicircular ridges not reaching canthus, outlining a frontal and an interorbital depression; trace of a pair of low frontal ridges; occipital depression rather shallow; head scales keeled; about twenty rows of larger scales on back, but more or less gradually merging into the granules on sides; keeled ventral scales perceptibly larger than dorsals; postanals more or less enlarged; leg reaches beyond eye; arm reaches groin; tail compressed, approximately 2.4 times body length; supralabials usually 10; infralabials 12-13; ventral scales keeled; head longer than tibia.

Description of type: A medium-sized species reaching a known total length of 283 mm., snout-vent length 83 mm.; body not or but slightly compressed, the tail definitely so (about 1.4 times as high as wide); head rather large, its length slightly less than twice its width, its height (11 mm.) slightly less than half its length; canthus rostralis not pronounced, consisting of four enlarged scales which extend little more than halfway from orbit to nostril; rostral about four times as wide as high, bordered by two labials and six other scales; snout elevated, covered with somewhat elongate bi- or tricarinate scales, the median largest; a pair of interorbital ridges running forward, diverging; trace of two parallel frontal ridges that enclose a slight depression, which is continuous with interorbital and occipital depressions, all of which are rather shallow; scales on floor of frontal depression longer than wide, arranged in longitudinal lines, bi- or tricarinate; scales of the semicircles have two or three keels on their outer faces, and two rows of scales separate them between orbits; supraorbital areas narrow, with four rows of keeled scales, somewhat enlarged, the inner row for the most part directly in contact with the semicircles; two rather short supraciliaries anteriorly, not reaching halfway across the supraciliary front; other scales of the supraciliary edge not especially differentiated; occipital area with a small occipital plate, less than one third of the area of the auricular meatus, surrounded by small scales, about four rows of which separate the occipitals from the scales of the semicircles; two low ridges bordered by swollen areas border occipital region, which is somewhat depressed; none of the scales of the semicircles much elongated; eight rows of scales in loreal region; scales of the subocular series strongly enlarged, not continuous behind eye with the semicircles, separated from the supralabials by a row of narrow

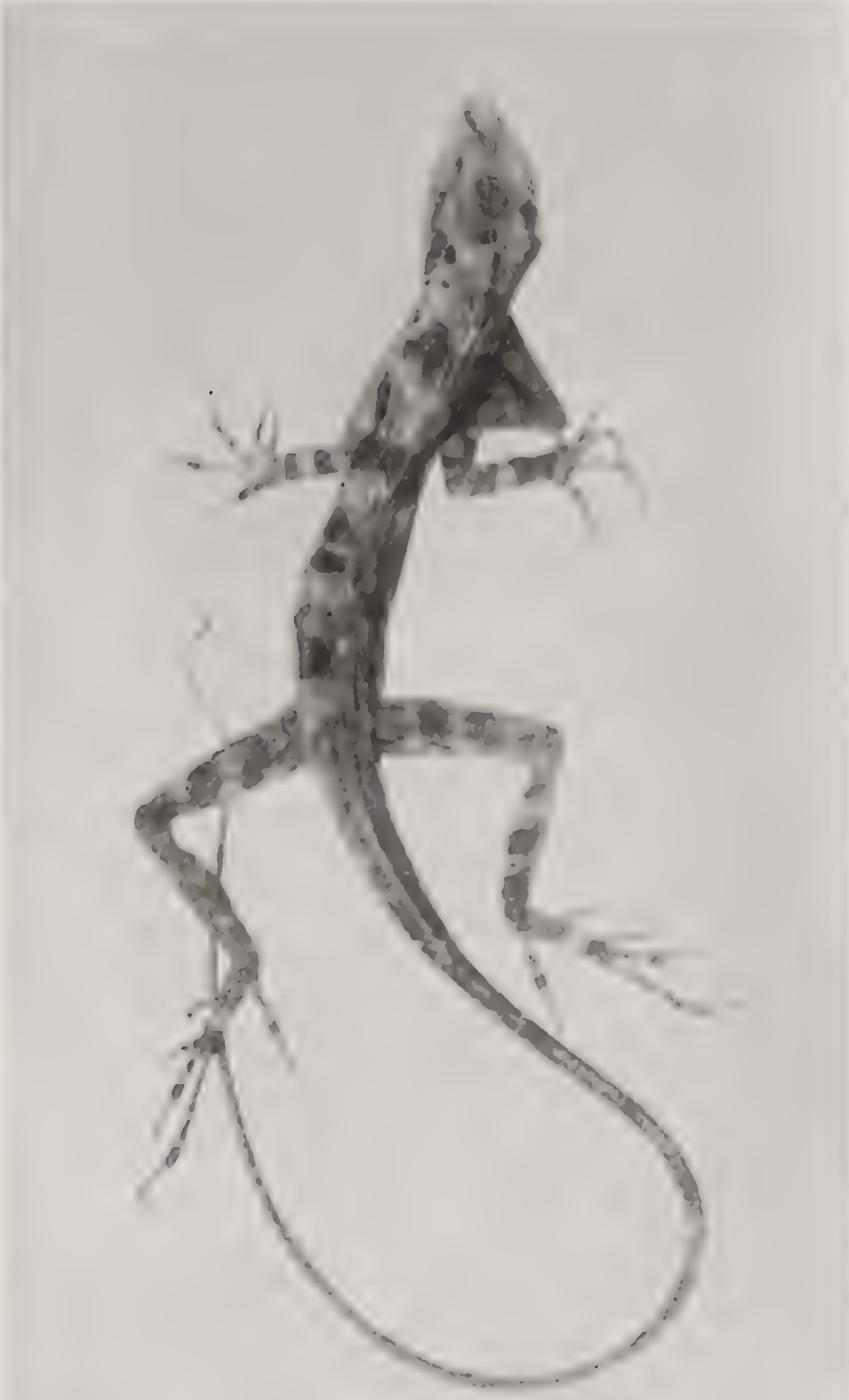

FIG. 32. *Anolis woodi attenuatus* subsp. nov. Type, KUMNH No. 34257; Isla Bonita (Cinchona), Heredia Province, C. R.; actual length, snout to vent, 82 mm.; total length, 283 mm.

scales; supralabials 10-10, the posterior reduced; 13-13 infralabials, the posterior small; mental divided for about .6 to .75 of its height by a suture entering from behind, its labial border shorter than that of the rostral; eight rows of somewhat enlarged scales border the infralabials; two labials and six other scales bordering mental.

Throat fan large, when distended about 30 mm. long and 26 mm. wide. Arms long, when extended they reach two or three millimeters past the groin; scales on top and front of upper arm and front face of forearm much larger than dorsal or ventral scales, keeled; 16 scales and lamellae under basal joints of middle finger, the digits moderately but distinctly widened; a depression, but no distinct axillary pocket behind arm insertion; leg long, slender, the tip of the longest toe reaching to a point beyond eye one third of distance between orbit and nostril; 27 scales and lamellae under middle toe (not counting those extending onto the sole); ten scales under distal joint; scales on front of thigh and tibia larger, keeled. A pair of somewhat enlarged median dorsal scalerows; adjoining eight rows distinctly larger than the small lateral granules into which they gradually merge; ventral scales a little larger than median dorsals, strongly keeled; about 140 scales and granules around body; median postanal scales somewhat enlarged, a little larger than scales that follow them, but much larger than scales in the depression in front of them; crest of basal part of tail with median paired scales (for 15 mm.) followed by a single row, broken occasionally by single pairs, all scales keeled. Scales forming rows on sides of throat fan are contiguous; tail compressed.

Color: In life, general color dull brick-red with variegated black markings. Throat fan very dark olive to blackish with magenta scales; under part of body salmon to pink, with some areas tending toward the dorsal coloration; areas on head, above eyes, greenish.

In preservative, generally fawn-brown to darker brown; head flecked and variegated with darker brown, and with minute black pigment spots; the greenish color in supraorbital areas persists with some darker transverse tracings; three darker spots below eye, and an indefinite short stripe behind eye; occipital region somewhat black; a strong blackish band on shoulder in front of arm, nearly meeting its fellow on neck, preceded by an area somewhat lighter; a somewhat lighter indefinite band on back behind arms, one at middle of body that is somewhat divided by lighter tan, and another indefinite band on sides of rump; arms with four or five indefinite bands, those on legs very dim; some indefinite cream spots on back of thighs; tail very indistinctly banded. Below, *Measurements in mm. and scale data of Anolis woodi attenuatus subsp. nov.*

Number	668	34257	34256
Sex	♂	♂	♂
Total length	260*	283	261
Snout to vent	83	82	78
Tail	177*	201	183
Snout to ear	21	21.2	20
Snout to foreleg	31.5	32.5	30
Axilla to groin	37	38.2	35
Head length to jaw angle	23	23.4	22.2
Head width greatest	12.6	13.2	12
Arm	40	38	39
Leg	69.2	71	69.1
Tibia	21	21	21
Foot and toes	31	31	29
Scales between ridges	2-3	2-2	2-2
Scales between ridge and occipital scale,	3-4	4-4	4-4
Labials and subocular series separated,	yes	yes	no**
Longest toe extends beyond eye	4 mm.	3½ mm.	5 mm.
Arm to beyond groin	yes	yes	yes
Nuchal crest present	yes	yes	yes
Occipital scale smaller than ear	yes	yes	yes
Scales behind rostral	6	6	6
Scales behind mental	6	6	6
Loreal rows	8-9	8	8
Supralabials	10-9	10-10	10-10
Infralabials	12-12	13-13	12-12

* Tip missing.

** Two scales are in contact.

chin with two broken transverse marks; belly and under limbs light fawn, with some scattering of brownish flecks. Throat-fan deep black with dark grayish scales; digits banded to tips.

Variation: Most of the variation not recorded in the table has to do with the distinctness of the color patterns. R. C. T. No. 668 shows the banding more distinct on the thighs; in KUMNH 34256, the markings are less distinct, the banding on limbs and digits scarcely discernible.

Remarks: These three specimens were taken at the American Cinchona Plantation at Isla Bonita on the southeastern slopes of Volcán Poás. They were rather brightly colored and conspicuous. Richard Taylor who observed a pair on the flattened top of a tree fern, made the following note:

"Two anoles, a male and female were observed on the top of a tree fern from the bank of a rivulet from about the same level as the top. When first seen I presumed them to be fighting. The male with dewlap extended would attempt to bite the female. Then the female would retreat to another frond, and shortly would return to attack the male. At one time in the procedure they came face to face with mouths open. The female retreated followed by the male, who at all times had the throat fan extended even up to the time I captured it. As I approached closer they became aware of my presence, and stopped, alert and motionless. The male was captured, but the female escaped. It is possible that this was a demonstration of courtship."

The length of the tail in this form is considerable and is equalled by the length of the tail in *Anolis longicauda* Hallowell. Boulenger in his Catalogue disregarded this latter species (mentioned in footnote, vol. 2, p. 11) and Barbour, Bull. Mus. Comp. Zool. Harvard Coll. places it as a synonym of *Anolis sericeus.* I would suspect that the two species, *longicauda* and this species are related. The type of *longicauda* is presumably lost, and the type description is inadequate. Only the acquisition of more material from the type locality of *longicauda* can settle completely the problem of the relationship of the subspecies.

Anolis townsendi Stejneger

(Fig. 33)

Anolis townsendi Stejneger, Bull. Mus. Comp. Zool. Harvard Col., vol. 36, no. 6, Nov. 1900, pp. 163-164 (type locality, Cocos Island, Costa Rica, Chas. H. Townsend collector); Proc. Biol. Soc. Washington, vol. 16, Feb. 21, 1903, p. 3 (mention only).

Diagnosis: A small *Anolis* characterized by having rostral touching anterior nasal scale, bordered behind by two labials, two nasals, and five small postrostrals; eight scales between the nasals; supraorbital semicircular ridges moderately well defined, separated by two or three rows of small scales; occipital scale larger than ear-opening, separated from the semicircular ridges by three rows of scales; a very small nuchal crest in males; keeled dorsals larger than laterals but smaller than the keeled ventral. A white lateral line from shoulder to groin bordered below by a black stripe; a row of postanal scales, somewhat enlarged.

Description of species: Rostral more than three times as wide as high, bordered behind by two labials, two nasals and five other scales; semicircles of enlarged scales begin somewhat behind eye and curve around supraorbital area continuing on to frontal area, separated by two rows of scales at narrowest point and anteriorly by five or six rows; supraoculars in about four rows, the inner row with the largest scales, but separated from ridges by a row of small scales; outer rows diminishing in size; occipital scale much larger than surrounding scales, larger than ear-opening but much smaller than eye-opening, separated from semicircles by two or three scale-rows; all head scales keeled; supraciliary scales elongate sharp-edged, overlapping; first canthal followed by a widened scale; five rows of frenals; a row of ocular scales, beginning close to a canthal scale, passing below eye, at least three of the scales in contact with supralabials; scales bordering the occipital somewhat enlarged; seven supralabials, the anterior rather elongate and keeled; seven or eight infralabials, anterior ones nearly smooth, posterior ones

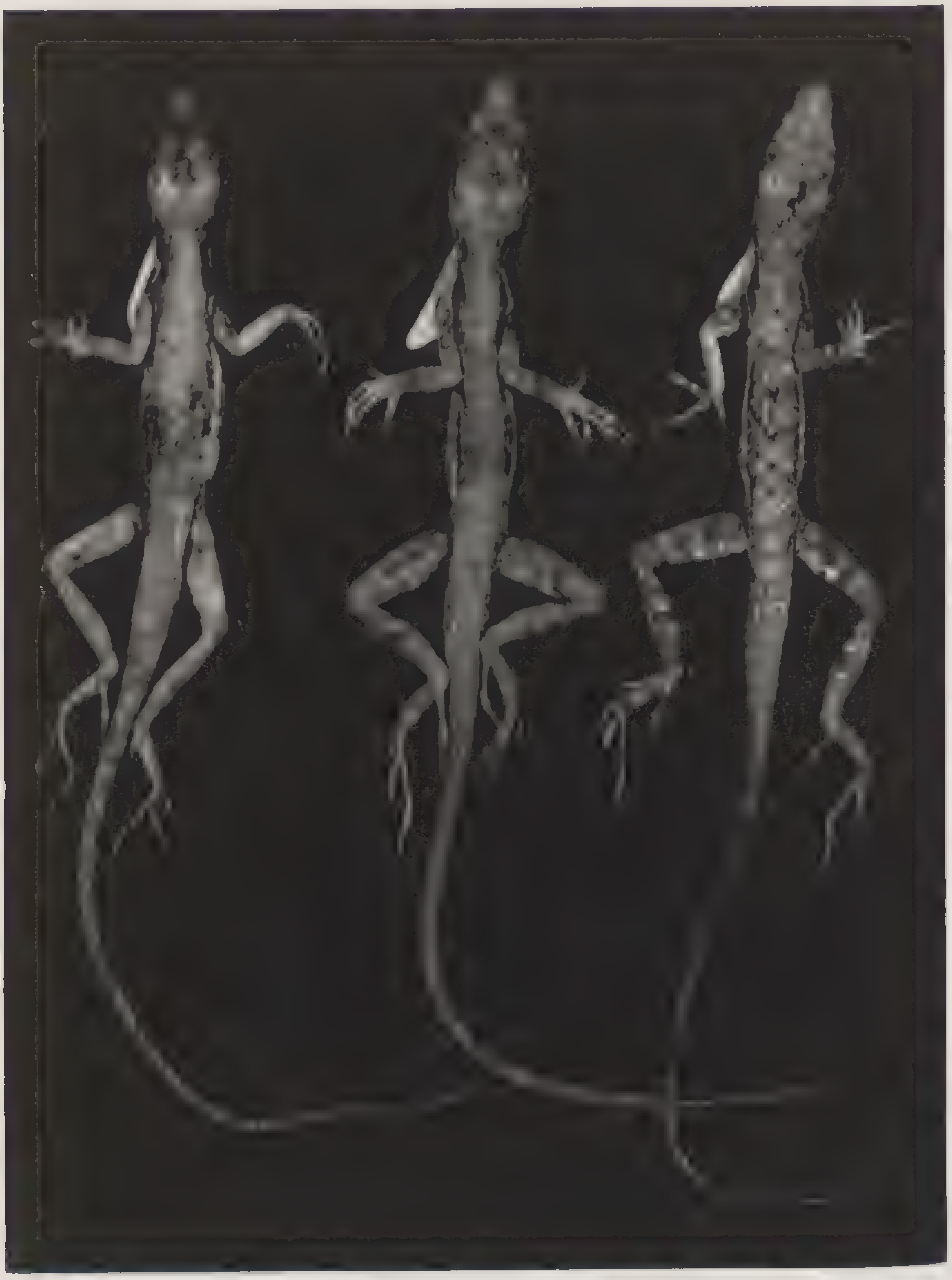

FIG. 33. *Anolis townsendi* Stejneger. Left figure, KUMNH No. 36493 ♂; actual length, snout to vent, 45 mm.; middle, No. 36501 ♂, length, snout to vent, 48.2 mm.; right, No. 36500 ♂, length, snout to vent, 46.5 mm. Cocos Island, C. R.

keeled; four or five outer longitudinal rows of chin scales somewhat larger than median series; mental divided by a groove into two moieties; bordered behind by eight scales the outer distinctly largest. A well-developed dewlap beginning on breast, its depth a little less than head length.

Scales on dorsum variable, the two median rows largest, the three or four adjoining also somewhat enlarged, all distinctly larger than the lateral granules; ventral scales slightly larger on the average than the median dorsal rows, all keeled, the keels directed inwards and backwards; scales and granules around middle of body about 112; postcaudal groove somewhat chevron-shaped and bordered behind by an arched row of scales at least four of which are enlarged; a single row of dorsal caudals, not or but little larger than adjoining scales, not serrate; tail rather cylindrical, rather indistinctly segmented, the scales forming whorls.

Arm laid forward the fingers reach snout tip; scales on front part of upper arm, and front face of forearm, larger than ventral body scales; the scales on front face of thigh, and front and dorsal parts of tibia similarly enlarged; fingers and toes widened except on ultimate joint; seventeen widened lamellae on two longest fingers, the distal joint with eleven scales; 28 widened lamellae under longest toe with ten scales under distal portion. No axillary depression or pouch; tympanum small in size, 1.25 mm. x .8 mm.

Color in life: Above, generally uniform olive with a golden yellow stripe beginning on shoulder in front of arm insertion, running back to groin, becoming somewhat diffuse posteriorly, bordered with blackish above and below. The dewlap is a deep amber, with a faint suggestion of olive; venter lighter, with a yellowish wash and metallic reflections.

When preserved one notes certain small median dorsal brownish spots; the dorsolateral region grayish, variegated with darker and lighter shades; legs more or less barred with dark and light, and with a few lighter golden flecks; chin, belly, and base of tail whitish.

Measurements in mm. KUMNH Nos. 36500 and 36501: Snout to vent, 47, 49; tail, 93, —; total length, 140, —; snout to ear, 13, 13.9; snout to arm insertion, 21, 21; length of head, 14, 15; width of head, 7.8, 8; axilla to groin, 19, 20; arm, 21, 23; leg, 39, 41; tibia, 13, 13.

Remarks: I collected KUMNH Nos. 36489-36508 on Cocos Island, June 14-17, 1954. The species was quite common along the forest edge near the seabeach. I found them in piles of trash, under palm leaves, and about drift on the beach where there was shade. When exposed they usually escaped to trees running up on the trunk a short distance where they were easily taken.

Only one other lizard is known on Cocos Island, a smaller species, *Sphaerodactylus pacificus* Stejneger.

Anolis capito Peters

(Figs. 34, 35, 36)

Anolis (*Draconura*) *capito* Peters, Monatsb. Acad. Wiss. Berlin, 1862, pp. 142-143 (type locality, Costa Rica. Dr. C. Hoffman coll., restricted to Palmar, Puntarenas Prov. by Smith and Taylor).

Anolis capito Bocourt, Mission Scientifique au Mexique et dans l'Amérique Centrale; Études sur les reptiles, livr. 2, 1873, pp. 101-103, pl. 16, figs. 27, 27a (figure of the head and tip of the tail of the type specimen); Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1876 (1875), p. 124 (Old Harbor [= Puerto Viejo] Limón Prov.); Boulenger, Catalogue of the lizards in the British Museum, 2nd Ed., vol. 2, 1885, p. 94-95 (Guatemala; Tabasco to Costa Rica); Günther, Biologia Centrali-Americana; Reptilia and Batrachia Oct. 1885, p. 52; Cope, Amer. Philos. Soc., vol. 23, 1886, p. 276 (Nicaragua); U. S. Nat. Mus. Bull. 32, 1887, p. 30 (places *A. carneus* Cope in synonymy); Dunn, Proc. New England Zool. Club, vol. 12, 1930, p. 18 (Corona, western Panamá); Barbour, Bull. Mus. Comp. Zool. Harvard Coll., vol. 77, no. 4, June 1934, pp. 126-127 (refers Cope's *longipes* to the synonymy of this species); Gaige, Hartweg, and Stuart, Occ. Papers Mus. Zool. Univ. Michigan, no. 357, Oct. 26, 1937, pp. 8-9 (Río Mico, 10 mi. above Recero, Nicaragua); Stuart, *idem. ibid.* no. 471, May 17, 1943, p. 18 (Guatemala); Misc. Publ. Mus. Zool. Univ. Michigan, no. 69, June 12, 1948, p. 47 (Guatemala localities); Smith and Taylor, U. S. Nat. Mus. Bull. 199, 1950, p. 65 (Mexican records); Stuart, Misc. Publ. Mus. Zool., Michigan no. 91, June 6, 1955, pp. 13-14.

Anolis carneus Cope, Proc. Acad. Nat. Sci. Philadelphia, 1864, p. 169 (type locality, Lower Verapaz forest, Guatemala).

Anolis longipes Cope, Proc. Amer. Philos. Soc., vol. 31, sec. 23, 1893, p. 343 (type locality, Palmar and Boruca, Costa Rica); Dunn, Proc. New England Zool. Club, vol. 12, Aug. 7, 1930, p. 21 (confuses this species with *Anolis purpurescens* stating that they are the same); Burt, Trans. Acad. Sci. St. Louis, vol. 28, no. 1, Aug. 1, 1933, p. 18 (includes *purpurescens* as a synonym, possibly on Dunn's authority).

Diagnosis: Width of mental equal to or less than width of rostral; head short, high; semicircular ridges distinct with a deep frontal depression; suboculars separated from labials by a single scalerow; six loreal series; two median dorsal caudals on base of tail, then a single median, the series not serrate; dorsal and lateral scales flat, smooth, subequal, juxtaposed, hexagonal, all smaller than the strongly keeled ventrals; leg reaches to eye, tip of snout, or beyond; occipital scale much smaller than ear, separated from semicircles by two or three scale series; semicircles at middle separated by two to four series; about 40 scales and lamellae under fourth toe; males with small dewlap, not or scarcely indicated in females.

Description of species (From KUMNH No. 34726, Esquinas Forest Reserve between Palmar and Golfito, Puntarenas Prov.): Rostral three times as wide as high, bordered by two labials and six post-

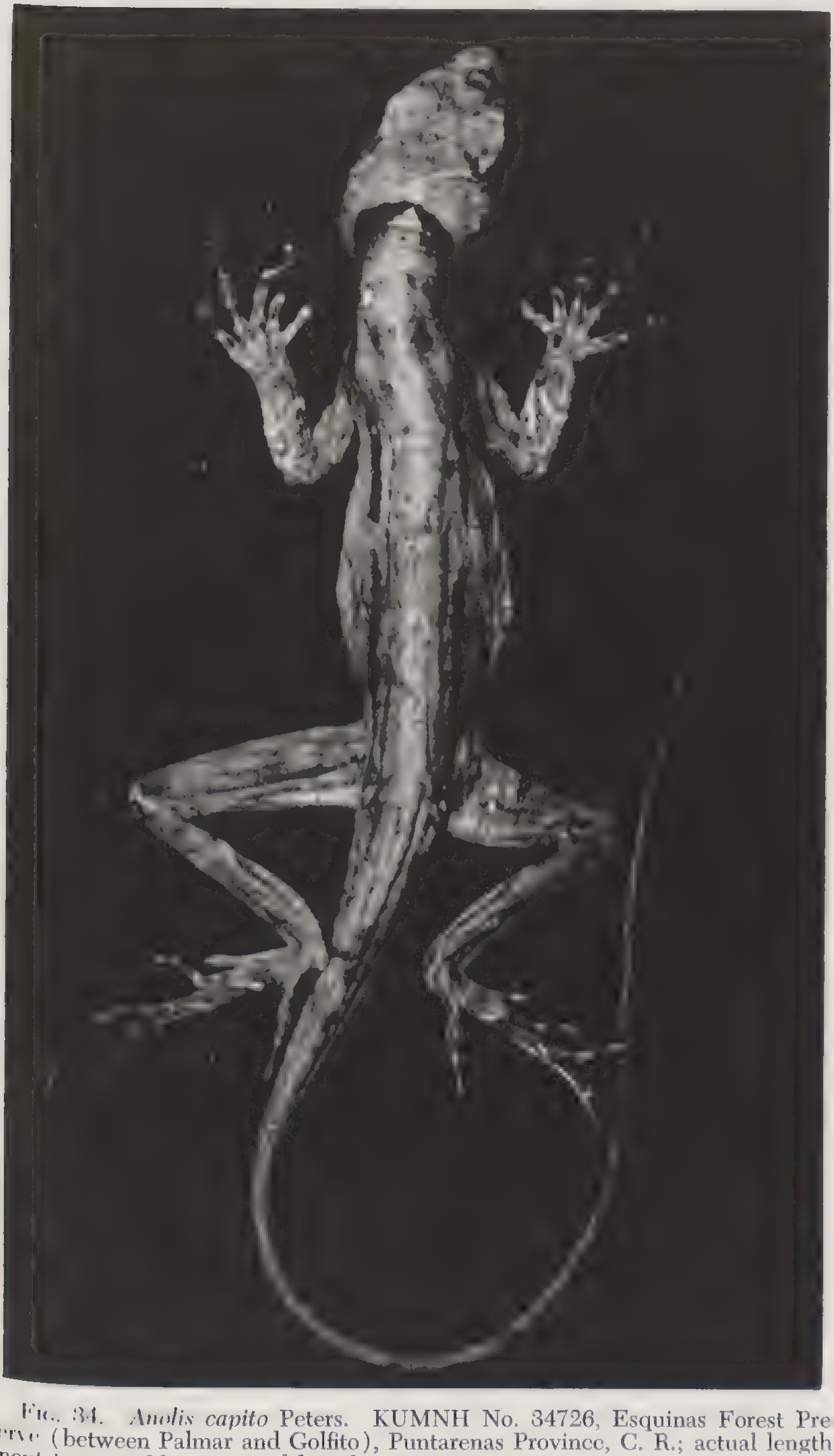

FIG. 34. *Anolis capito* Peters. KUMNH No. 34726, Esquinas Forest Preserve (between Palmar and Golfito), Puntarenas Province, C. R.; actual length, snout to vent, 90 mm.; total length, 261 mm.

rostrals, the two median largest, and separated from nasal by two scale series; nostril surrounded by a single narrow scale; frontal area excavated, declivous; semicircles extend from posterior supraciliary border around the supraocular areas to frontal region, the anterior scutes much enlarged, the ridge tending to bifurcate near front of supraocular area, one or two scales separating the series between eyes; supraorbital area nearly covered with supraoculars, arranged in about four irregular rows and totaling about 24 scales of varying size; three supraciliary scales overlapping, the anterior large, thickened; a double row of smaller scales are along the posterior supraciliary border; canthal scales about four, the two anterior small; the third is much elongated with a sharp lateral edge; six rows of loreals, the lowermost continues back and separates the suboculars from the labials; a small occipital depression; the occipital scale small, separated by three scale series from the semicircles, about one fourth area of ear-opening; the scales surrounding occipital irregular, the scales lateral to these on the swollen occipital areas also large, hexagonal; two horizontal rows of temporals; lateral temporals smaller than body scales; a suggestion of a transverse ridge immediately behind the eyes scarcely indicated mesially; two vertical rows in front of ear noticeably enlarged; twelve supralabials the tenth below middle of eye, all very rugose, with the posterior and lower edges of each elevated; about fifteen infralabials; four or five scale series along infralabials somewhat enlarged; mental a little less wide than rostral, bordered by two labials and six or seven postmentals; gular dewlap small in males not or but scarcely indicated in female; scales on chin and neck much smaller than ventrals; dorsals, nuchals and lateral scales subequal, a little larger in rump area, all polygonal, usually hexagonal, juxtaposed, flat, smooth; head scales, except temporal and lateral occipitals, keeled and somewhat rugose; about 108 scales and granules in a row around middle of body; ear-opening about five sixths of eye-opening; arm reaching to insertion of femur; fourth finger longest, all except first widened, with eighteen widened lamellae and 14 scales on distal joint; on distal joint the proximal scutes are double or triple; leg elongate, the fourth toe reaching slightly beyond tip of snout; fourth toe with 28 lamellae and 15 scales; on foot following first toe, a series of enlarged scales extending to heel; dorsal and anterior scales on upper arm, on dorsal part of lower arm, on front of thigh, and front and ventral surface of the tibia, enlarged, keeled. Other scales of limbs may be keeled or in some parts smooth. Tail with two median ventral series largest; basal

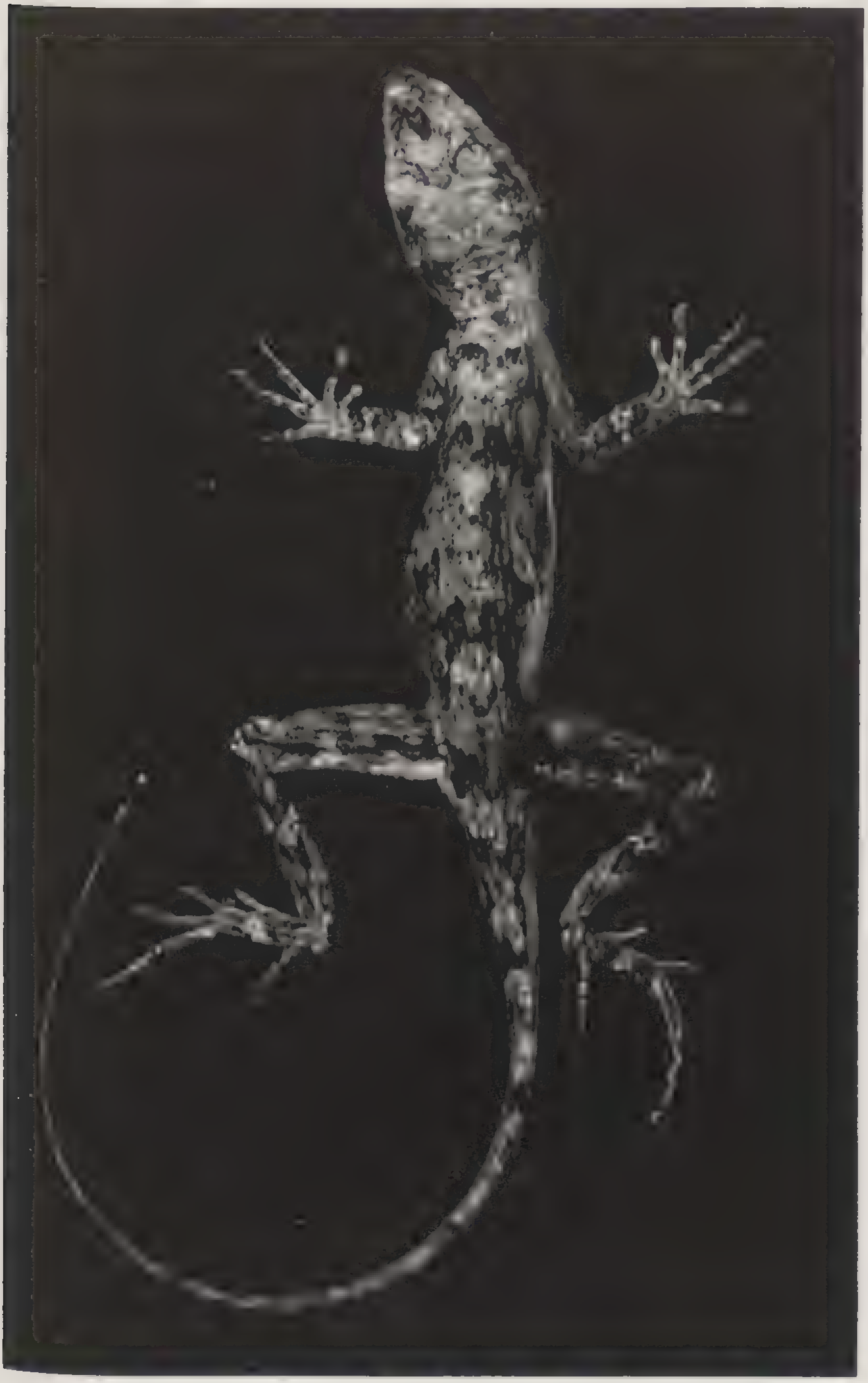

FIG. 35. *Anolis capito* Peters. KUMNH No. 34721; Los Diamantes, Guápiles, Limón Province, C. R.; actual length, snout to vent, 83.5 mm.; total length, 231 mm.

part of tail with two median dorsal scalerows, varied more posteriorly, then continued as a single row; all scales of tail keeled but the dorsal part is not serrate.

Color (female): Beginning behind occiput a broad dorsal golden-brown stripe covering 16 median rows of scales, bordered by blackish brown stripes that unite anteriorly on occiput, each bordered by a golden line on upper edge continuing onto tail; the sides are greenish yellow, more or less uniform; belly cream to yellow-white, grayish in gular region; bronzy brown on back of thigh; a fawn band on arm; side and top of head olive brown; tail brownish, not barred; after preservation some indistinct darker streaks are evident on the sides.

Measurements: See table.

Variation: The pattern of males and many females consists of an olive to olive-brown ground-color on which one discerns three transverse body blotches and one at the base of tail, bordered anteriorly by a fine dove-tailing line of black. There is usually a black or brown chevron-shaped head-band crossing front part of supraocular regions; another band across frontal area, and a dim one across snout. The young specimens show that these bands continue diagonally on the sides of head, the posterior crossing the eye and terminating near mouth angle; the next forward crosses lips and continues under chin. The underside of chin shows two transverse cream lines separated by darker bands; this banding can also be discerned in several half grown and in some adults. In the younger specimens the tail may be banded in brown and fawn. The male has a diminutive dewlap not very conspicuous in preserved specimens.

A specimen from Golfito (No. 34724), a young male, 72 mm. snout to vent has the typical head markings scarcely discernible, and the dorsal blotches almost completely obsolete. There are nine scales between nostrils and the mental is distinctly smaller than the rostral.

The most puzzling color variant is a young specimen from Moravia de Chirripó (No. 34725). There is a hair-fine median golden line bordered on each side by a narrow irregular brownish lavender stripe two to three scales wide, with some dark irregular longitudinal streaks; below this a broken blackish-brown stripe darker along its borders. The sides have three other series of discontinuous streaks, while low on sides the markings, more numerous and shorter are continued to middle of venter. The head marks differ,

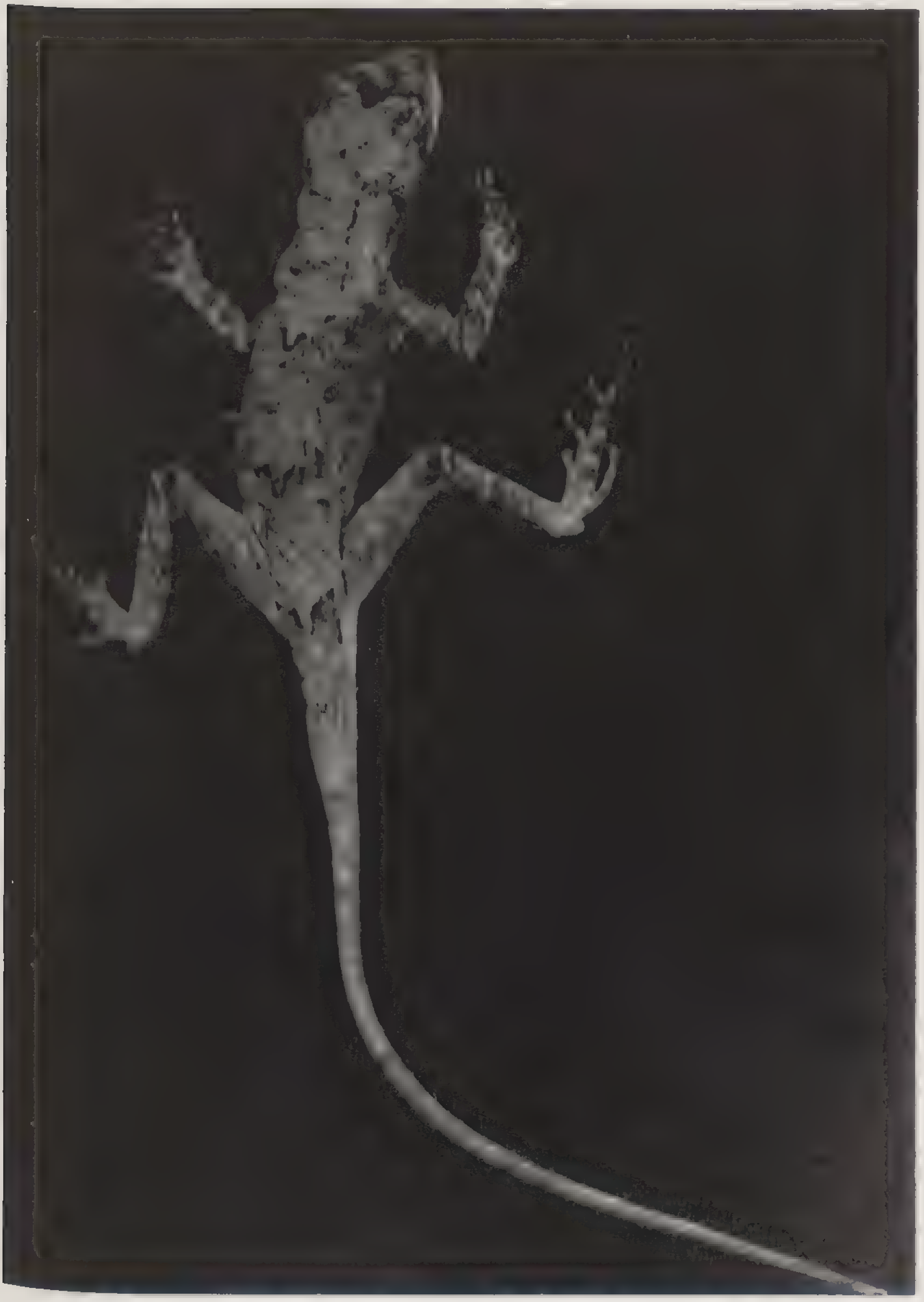

FIG. 36. *Anolis capito* Peters. KUMNH No. 34723, Atirro, Cartago Province, C. R.; actual length, snout to vent, 72 mm.; tail, 120 mm.

the posterior covering most of supraocular area and the point of the chevron almost touches occipital. There is a clay-white mark across the jaw angle and in front of ear-opening. The variation is puzzling.

Remarks: Specimens are at hand from the following localities: Cartago Province: KUMNH Nos. 34717-34718, Morehouse Finca, 5 km. SE Turrialba; 34720, Peralta. Limón Province: 34721, Los Diamantes, Guápiles; 40572-40576, Suretka; 34722, 34725, Moravia de Chirripó. San José Province: 34723, Atirro. Puntarenas Province: 34774, Golfito; 34726, Esquinas Forest Preserve between Palmar and Golfito. The species has been reported in Mexico, British Honduras, Guatemala and Nicaragua.

Cope described *Anolis longipes* from Palmar and Boruca. It would appear that the specimen described is very similar. At first glance this specimen seems very different from specimens from eastern Costa Rica. However the particular color pattern (a broad median golden or golden-brown stripe) occurs in the females of many species of Costa Rican *Anolis.*

Cope's species, *Anolis carneus* described from "Lower Verapaz forest Guatemala", agrees in considerable detail with eastern Costa Rican specimens, especially as concerns the dorsal coloration. Seemingly it is a larger specimen than I have seen, having a snout-vent length of approximately 95 mm. The tail is somewhat shorter (160 mm.) than the specimen here described. The smallest specimen examined measures 30 mm. snout to vent.

A round worm about 1 centimeter in length was found burrowed beneath the skin of No. 10568.

Measurements in mm. and scale data on Anolis capito

Number	34726	34720	34721	34719	34724	34723	34725	34718	40573
Sex	♀	♂	♀	♀	♂	♀	♀	......	♂
Total length	261	236	231	222	206	192	120	127	205
Snout to vent	90	85	83.5	82	74	72	50	51	74
Tail	171	151	147.5	140	132	120	70	76	131
Snout to ear	25	22.5	22	21.2	19.5	18	14	14.7	18.6
Snout to foreleg	39	33	34	32.3	28	27	23	22.5	29
Axilla to groin	38	39	35	35	29	31.5	20	22	33
Head length	26.3	24	24	23	22	19.8	15	16	20
Head width	17.2	16.2	15.2	15	13.5	13.9	11.6	11	13.6
Height of head	14.2	12	11.7	12.2	10.9	12	8.2	9	10.3
Arm	40	44	35	35	31	33	21	28	36
Leg	84	80	70	76	60	61	39	40	68.5
Tibia	26	23	24	24	20	20	12.6	13.4	24
Foot and toes	35	31	28.5	28	24	25	15.6	13	26
Scales between ridges	2	3	2	2	1–2	2	3–2	2	2
Scales between occipital and ridges	3–3	3–3	2–3	3–4	2–2	3–3	3–3	3–3	3–3
Postrostral scales	6	6	8	6	7	7	7	6	7
Postmental scales	6	6	8	4	6	5	6	6	6
Supralabials	12-12	12-13	12-12	12-13	10-10	12-13	11-12	12-13	13-12
Infralabials	14-15	15-15	14-15	14-15	11-13	16-16	15-15	14-14	14-14
Scale about midbody	108	106	105	104	89	116	96	100	112

Anolis biporcatus Wiegmann

(Fig. 37)

Anolis biporcatus Wiegmann, Herpetologia Mexicana 1834, p. 47 (type locality "Mexico"; by restriction Piedra Parada, Chiapas).

Anolis copei Bocourt, Mission Scientifique au Mexique et dans l'Amérique Centrale, Études sur les Reptiles, livr. 2, 1873, pp. 77-78, pl. 15, figs. 10, 10a (type locality, Santa Rosa de Pansos, Guatemala); Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1876 (1875), p. 121 (3 specimens from Old Harbour, Costa Rica. "Color in life blue and brown. This animal haunts sunny spots on the edge of the forest."); Boulenger, Catalogue of the lizards in the British Museum, 2nd Ed., vol. 2, 1885, p. 65-66, (Verapaz, Alta Verapaz, in Guatemala; Costa Rica, W. Ecuador [one of the types of *A. fraseri*]; spelled *copii*); Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Oct. 1885, p. 47 (Guatemala and Costa Rica, [spelled *copii*]); Cope, Proc. Amer. Philos. Soc., vol. 23, 1886, p. 276 (Nicaragua); Boulenger, Proc. Zool. Soc. London, 1898, p. 111 (Paramba, Ecuador [spelled *copii*]); Dunn, Proc. New England Zool. Soc., vol. 12, 1930, p. 19 (places *obtusirostris* and *brevipes* in synonymy); Barbour, Bull. Mus. Comp. Zool., Harvard Col. vol. 77, no. 4, 1934, p. 128; Gaige, Hartweg and Stuart, Occ. Papers Mus. Zool. Univ. Michigan, no. 357, 1937, p. 9, (Río Siquia, Nicaragua, 7 mi. above Rama); Wettstein, Sitzungsb. Akad. Wiss. Wien, Abt. 1, Bd. 143, Heft 1-2, 1934, p. 21 "Tilleran" C. R. identification questioned by author.

Anolis fraseri (*part.*) Günther, Proc. Zool. Soc. London, 1859, p. 407 (one specimen of *A. copei* included in the types from the "Andes of western Ecuador." This is figured by Bocourt *loc. cit.* plate 15, fig. 12, [not fig. 10 as stated by Barbour *loc. cit.*]; locality uncertain); Boulenger, Catalogue of the lizards in the British Museum, 2nd Ed., vol. 2, 1885, p. 65.

Anolis brevipes Boettger, Cat. Rept. Senck. Mus., vol. 1, 1893, p. 57 (type locality, Cairo plantation, La Junta near Limón, Costa Rica); Ber. über Senckb. Naturforsch. Ges. in Frankfurt am Main, 1893, p. XXVIII and 1893, p. LXXIII (mention of type of *brevipes*).

Anolis obtusirostris Peters, Monatsb. Akad. Wiss. Berlin, Jan. (or Feb.) 1874, p. 741 (type locality, Chiriquí Prov. Panamá); Boulenger, Catalogue of the lizards in the British Museum, 2nd Ed., vol. 2, 1885, p. 95.

Anolis petersii Schmidt, Smithsonian Misc. Coll., vol. 89, Mar. 16, 1933, p. 9, Gatun, Canal Zone.

Diagnosis: Large species (reaching 102 mm. snout to vent), somewhat triangular in cross section; scales on back and sides small, convex, moundlike, ridged or slightly keeled on back and sides, nearly uniform save for two slightly enlarged median dorsal series; venter with scales two to three times as large as dorsals, imbricate, strongly keeled as are the adjoining small scales low on sides; groove does not completely divide mental; suboculars separated from labials by a row of scales (or except for one or two points of contact); head scales generally unkeeled except on snout; leg reaching just anterior to arm insertion or to ear; head longer than tibia; arm three fourths of axilla-to-groin distance; occipital depression shallow, dimly outlined by the occipital elevation or ridges; frontal depression shallow; postanals enlarged.

Description of species (From KUMNH No. 34249 Los Diamantes, Gúapiles, Costa Rica); Body compressed but little, head elongate; rostral at least four times as wide as high, bordered behind by five postrostral scales and two labials; ten scales between nostrils, thick, keeled; frontal depression shallow, continuous with the interorbital and occipital depressions, its floor covered with flat scales; circumorbital semicircles forming a low ridge, not or scarcely discernible on the frontal region, the scales without or with very

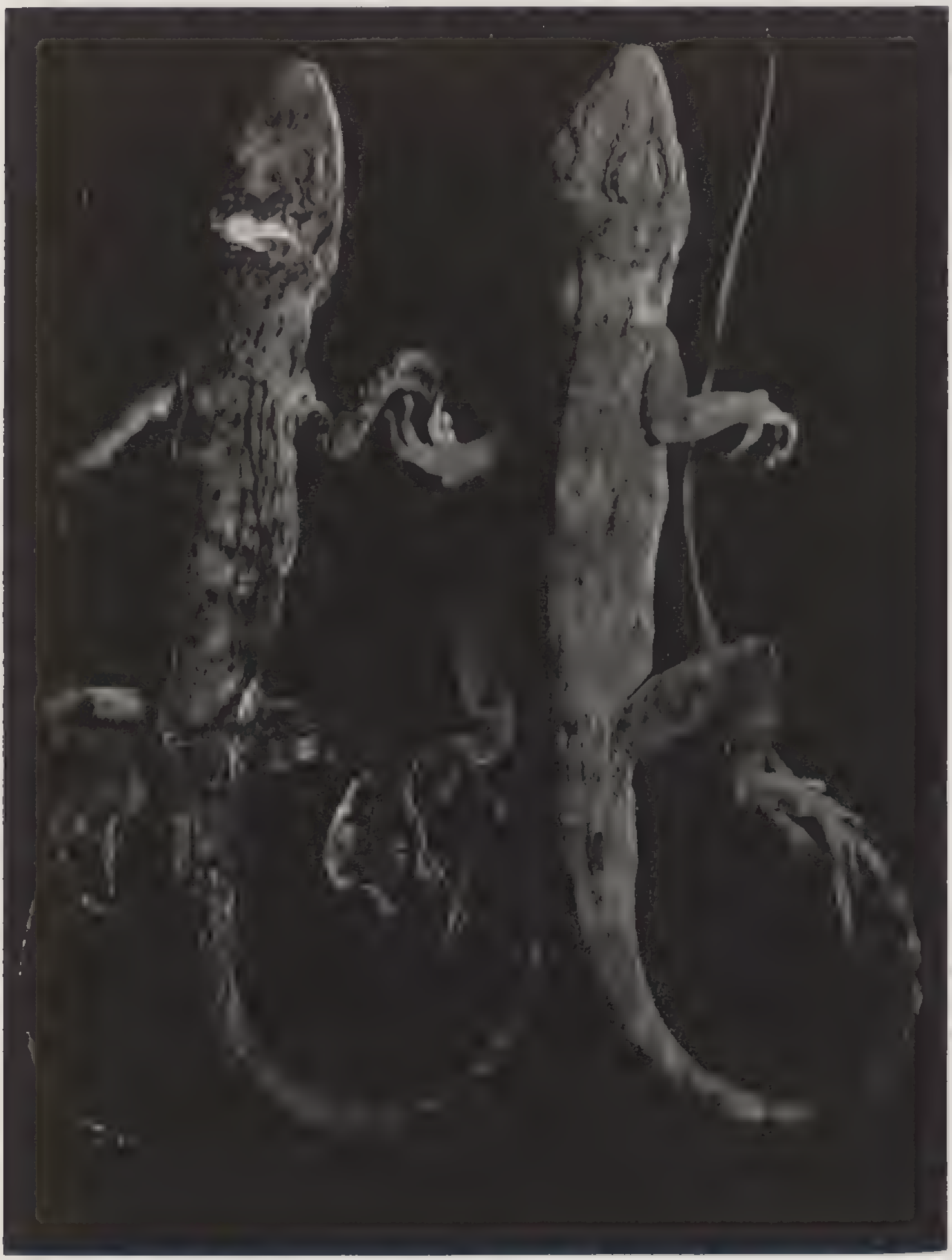

FIG. 37. *Anolis biporcatus* Wiegmann. Tronadero, Lake Arenal, Guanacaste Province. Left figure, KUMNH No. 40567; actual length, snout to vent, 93 mm.; tail, 213 mm.; right figure, 40568, actual length, snout to vent, 92 mm.; tail, 200 mm.

indefinite keels, the anterior ones enlarged; behind eye this series is continuous with the subocular series that terminates in the loreal region and is separated from the labials by an intercalated row of scales (that is continuous, save for two points on the right, one point on the left side, thus permitting contact with the labials at these points); four enlarged scales forming a sharp canthus; two elongate supraciliary scales followed by two smaller scales; scales of circumorbital semicircles separated by three (two) scalerows; occipital depression bordered by two ridges or moundlike elevations, the area covered with small scales; a transverse row of somewhat larger scales continued back of the eye; supraocular region with three rows of irregularly enlarged scales bearing low keels that are separated from the semicircles by a row of smaller scales; nine scales between canthi in front of the frontal depression; twelve scales between the first canthal scales; eleven supralabials to middle of eye, followed by two smaller scales; twelve infralabials; mental with a wider lip border and greater height than rostral, divided for about four fifths of its length by an entrant suture and bordered behind by two labials and eight postmental scales, the two outer not enlarged; six scalerows bordering infralabials enlarged, heavily keeled; the other gular series smaller, thickened, and keeled; seven loreal series; occipital scale about size of the auricular meatus, separated from the semicircles by three scales; keels on labials longitudinal; no enlarged scales on front edge of ear; scales on dorsum and sides juxtaposed, nearly uniform, save for certain slightly enlarged median rows, the scales thick, rounded, with a ridge or keel; about 100 scales and granules around body; males with a slight nuchal ridge or crest; leg reaches to front of ear; scales of arms keeled, those on front face of forearm distinctly larger than others; scales on back of thigh large; on tibia the larger scales are on both front and back edges, all more or less keeled; ventral scales more than double size of dorsals, keeled, often mucronate, imbricating; tail slightly compressed with a dorsal series of enlarged scales at top, keeled but not spiny or serrate; subcaudals, including those under base of tail, keeled; postanal depression in males with a chevron-shaped series of enlarged postanal scales, some larger than others. Broad scales and lamellae of fingers (excluding distal phalanx) with the following formula: 4-8-17-21-12 for foot 4-15-24-35-21; throat fan (dewlap) in males small, scarcely reaching breast; its length less than head length. A throat fan indicated in females.

Color: In life, brilliant yellow-green above, yellowish white below except for a darker area on throat; tail darker, banded with light fawn. In preservative, nearly uniform violet-brown, the venter lighter gray and fawn with brown longitudinal fine lines on throat; small flecks and spots of brown on venter and underside of thighs; the tail dark brown, the narrow light banding only slightly indicated; a slightly lighter area on back of head, the median and frontal parts lead color.

Variation: Many of the significant variations are evident in the data given in the appended table. The scales generally, in the supraorbital areas, vary somewhat in number and size. In one specimen three scales are double the size of adjoining scales.

When specimens are submerged in clear liquid, darker spots are in evidence. These dark spots on the body differ, and in No. 34249 they seem to coalesce to produce four indefinite dorsal bands, that extend on sides to venter. No. 34250 has four lighter dots on the back, the underside of the chin and venter showing but little pigment. The light bands on the tail vary in their distinctness.

Males have a small throat fan barely reaching the breast. In life the fan, or dewlap, is white or slightly greenish but preserved specimens show considerable pigment in the fan. The canthi are distinct in all[*] and a slight nuchal crest may be indicated. Bocourt states that the type has the dorsal scales feebly keeled. The keels are not strong, but very faintly indicated in all cases in Costarican specimens examined. The hind leg varies somewhat in its reach but probably never reaches farther than the eye. Color changes in life are made with considerable rapidity.

Remarks: The specimens in the KUMNH Collection are from the following localities: Cartago Province: KUMNH Nos. 34247, 34251, Morehouse Finca near Turrialba. Limón Province: Nos. 34248, 34249, 34250, Los Diamantes, near Guápiles, No. 34252, La Lola, No. 34253, Tunnel Camp near Peralta, No. 40570 Suretka. Guanacaste Province: Nos. 40564, 4 to 5 km. ENE Tilarán; 40566-40569, Tronadero, Tilarán, 40571, 4 km. ESE Los Angeles de Tilarán. It has also been reported from Limón, Costa Rica. Outside of Costa Rica it has been reported from Guatemala, Nicaragua, Panamá, and Ecuador.

Remarks: When captured No. 40570 had just swallowed a specimen of a smaller species, *Anolis lemurinus lemurinus*. The hind legs were sticking out of the mouth and it is doubtful that it could have been completely engulfed until it had been partially digested.

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[*] Dunn (loc. cit. 1930), referring to the type of *copei* states, "Four scales between semicircles; no canthus rostralis; small scales in semicircles; weak ventrals," all statements differing from Bocourt's statements and figure.

When removed from the digestive tract the specimen showed no deterioration due to digestion. The *A. capito* measures 88 mm. snout to vent, while the *A. l. lemurinus* is 50 mm. snout to vent. The thick basal portion of the tail, still attached, adds 14 mm. more to the length.

Anolis lionotus Cope

(Fig. 38)

Anolis (Dracontura) lionotus Cope, Proc. Acad. Nat. Sci. Sci. Philadelphia, Aug. 1861, pp. 210-211 (type locality, Cucuyas [= Cucuyos] de Veragua, New Granada [= Panamá]; an abandoned mine on the Río Santiago, *fide* Barbour).

Anolis lionotus Boulenger, Catalogue of the lizards in the British Museum, vol. 2, 1885, p. 70 (repeats Cope's description); Dunn, Proc. New England Zool. Club, vol. 12, 1930, p. 18 (Suretka and La Hondura, C. R.; places *rixii* and *oxylophis* in synonymy); Burt, Bull. Amer. Mus. Nat. Hist., vol. 61, June 11, 1931, p. 269 (Columbia); Barbour, Bull. Mus. Comp. Zool., Harvard Coll., vol. 77, no. 4, 1935, p. 140-141; Gaige, Hartweg, and Stuart, Occ. Papers Mus. Zool. Univ. Michigan, no. 357, 1937, pp. 9-10 (a variant mentioned from Nicaragua).

Anolis oxylophus Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1876 (1875), p. 123, pl. 24, fig. 4, pl. 28, fig. 5 (SE Costa Rica by inference, presumably from Sipurio, Limón Prov.); Boulenger, Catalogue of the lizards in the British Museum, vol. 2, 1885, p. 85; Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Oct. 1885, p. 51 (Costa Rica); Cope, Proc. Amer. Philos. Soc., vol. 23, 1886, p. 276, (Nicaragua); U. S. Nat. Mus. Bull. 32, 1887, p. 31 (the species *lionotus* is omitted from this work); Dunn, Proc. New England Zool. Club, vol. 12, 1930, pp. 18-19; Barbour, Bull. Mus. Comp. Zool., Harvard Coll., vol. 77, no. 4, June 1934, p. 140-141 (Nicaragua, Costa Rica; western Panamá to Canal Zone).

Anolis rixii Boulenger, Proc. Zool. Soc. London, 1894, p. 727, pl. 48, fig. 1 (type locality, Chontales Mine, Nicaragua).

Diagnosis: Medium large, semiaquatic species, characterized by about 20 rows of enlarged pentagonal or hexagonal dorsal scales, occasionally oval or subcircular in shape, with or without slight keels on some scales; occipital about size of ear-opening; semicircular series separated by from one to three scalerows; nine loreal series; suboculars separated from labials by one scalerow; mental much wider than rostral, its depth (height) scarcely more than twice width; a large gular fan (dewlap); ventrals as large as largest dorsals, strongly keeled; postanals somewhat enlarged; usually a large shallow axillary depression evident; about 115 scales around middle of body; a cream stripe from eye through ear, passing above arm to near groin, bordered below by a brownish-olive stripe and above by a broad dark olive band, narrowest just behind eye; dorsum faintly blotched; tail compressed and strongly banded; leg reaches near to orbit.

Description of species (From KUMNH No. 34157 Turrialba C. R.): Rostral twice as wide as high, the sides truncate, bordered behind by two labials and eight postrostrals; about ten scales be-

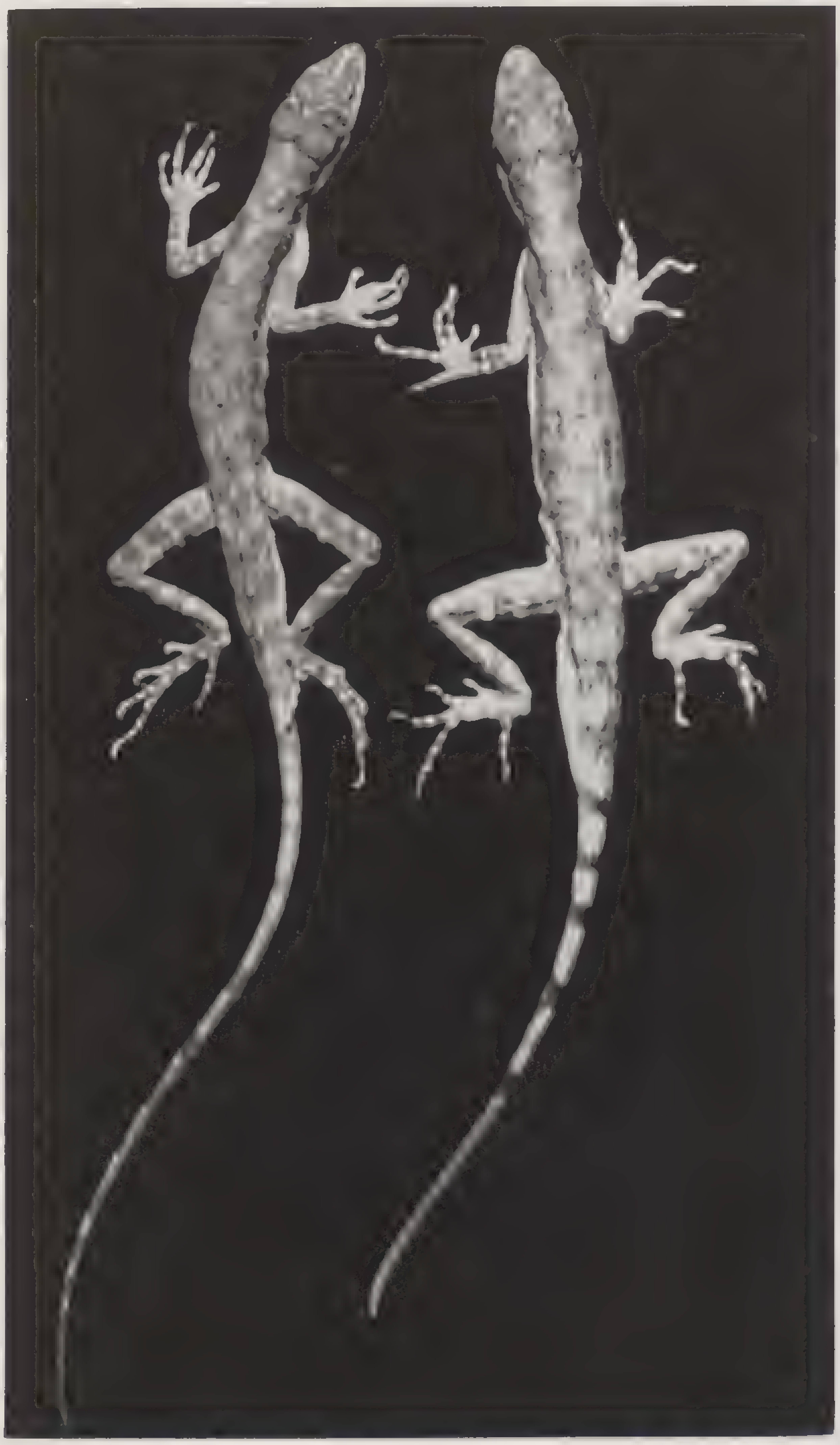

FIG. 38. *Anolis lionotus* Cope. Left figure, KUMNH No. 34158, Río Reventazón, Turrialba; actual length, snout to vent, 68 mm.; right figure, No. 34157; actual length, snout to vent, 76 mm.

tween nasal scales which consists of a narrow rim; latter separated from the rostral by a single scale; supraorbital semicircles composed of about ten scales forming a low ridge beginning behind eye near supraciliary border and terminating in frontal area, separated mesially by three series of scales, anteriorly at termination by six series; only slight interorbital and frontal depressions; supraocular area with a clearly delimited group of six much-enlarged keeled scutes, with four or five smaller scales, separated from semicircles by small granules; occipital (usually touched by two enlarged scales) longer than wide, about equal in area to the ear-opening, separated from the semicircles by three scale series; a large supraciliary followed by one or two smaller ones, scales on posterior supraciliary border not enlarged; canthal series of four scales; nine loreal series; suboculars few, enlarged, separated from labials by one or two rows of scales; nine enlarged supralabials; eleven infralabials the posterior borders of mouth with small granular scales; a sinuous double series of relatively small median temporal scales; mental border much wider than that of rostral, its length (height) in its width, two and one-eighth times; scale divided by a groove for three fourths of its length, and followed by two labials and nine postmentals; several scale series bordering infralabials larger than the median chin series; a large gular dewlap, its depth equal to about four-fifth times the length of head. About twenty scalerows on dorsum enlarged, variable in shape from polygonal to subcircular, many with dim keels or rugosities; outer rows gradually merging into granules on sides which are generally smooth but become keeled as they approach the enlarged keeled ventral scales; about 125 scales and granules around body; postanal scales somewhat enlarged; tail compressed strongly, the scales keeled throughout; the median dorsal row enlarged, not serrate; two median ventral rows also enlarged; only a very faint elevation of the two median nuchal rows; nine series of loreal scales, keeled; scales on snout not keeled but the edges may be slightly elevated; a large deep postaxillary depression; digits not greatly widened; 16 lamellae under wider part of fourth finger, ten scales under its distal joint; arm not reaching groin; leg, laid forward, the longest toe reaches to edge of orbit; scales on dorsal part of upper arm, front and dorsal part of forearm, front and dorsal part of thigh, and most of the scales on tibia much enlarged and strongly keeled; ear small, 1.2 mm. x .9 mm.

Color in life: Above, nearly uniform olive with faint indication of a series of dorsal blotches; a darker lateral olive-brown band on which are some hieroglyphlike marks and an indefinite series of distant small ocelli, which extend from neck to near groin; a cream line from eye to near groin; a small brown line from ear to mouth angle; labials light bronze. All under surfaces nearly uniform light cream with a yellow wash; dewlap light orange. Tail banded in dark and light olive; regenerated part of tail blackish; limbs barred with fawn.

Measurements in mm.: Snout to vent, 71.5; tail (partly regen.), 92; snout to ear, 18; snout to arm insertion, 30.5; axilla to groin, 33; length of head, 20; width of head, 11.6; arm, 29.5; leg, 53; tibia, 20.

Variation: This species is somewhat variable in color but the females do not seem to develop the median linear markings so common in many groups of *Anolis.* However the character of the dorsal blotching, and the length of the lateral light line is variable, but not necessarily a sex character. In many young specimens, especially, there is a series of black hieroglyphs in the brown lateral stripe. One just above arm insertion may have a deltoid shape; others may be similar to the letter O; with these there is a series (not always discernible) of small ocellate cream marks which may persist in preserved specimens. The tail banding may be brown and fawn, without olive. A specimen from Isla Bonita (40579 ♀) has the dorsum uniform gray-olive, and the brown lateral band (almost black on neck) has become partly broken up into a series of irregular dark-edged spots; the tiny ocelli occupy spaces between the brown spots. One from Turrialba (No. 34159 ♀) has the band broken (or partially so) into eight spots. These are connected across the neck, back, and base of tail by as many narrow brown chevrons, the angles directed backward; tiny ocelli are likewise present between spots. Specimens from Guanacaste (Tilarán and Tenorio) have the dark ventrolateral area strongly punctate with cream. The head markings usually show a median lighter-olive area on snout with darker olive on each side, a transverse chevronlike band across head, and other marks behind eyes failing to meet mesially. A specimen from San Isidro del General has a bright cream spot running under the eye to ear. Variation in the character of the supraoculars, which range in number from four large subequal keeled scales to ten of variable size does not seem to be geographical. The degree of keeling or rugosity on the dorsal scales, likewise variable, may or may not be due to geography. It seems to differ some with age. The ventral scales are always strongly keeled. The lateral white line may reach the groin or it may terminate shortly behind the level of the axilla. The axillary depression is strongly evident in fully adult specimens, but not necessarily so in young specimens.

Remarks: Cope described *Anolis lionotus* from Cucuyos, Veragua Province, Panamá in 1861, and *Anolis oxylophus* from Southeastern Costa Rica either from lowlands or the sides of Pico Blanco, in 1875. Certain subsequent authors have regarded the forms as distinct; others (Dunn and Barbour) have placed *oxylophus* as a synonym of *lionotus.*

Unfortunately I do not have available Panamanian material. The differences are seemingly significant, the most important being, that, as described, *lionotus* has smooth dorsals, smooth ventrals, twelve instead of twenty rows of enlarged scales and the longer hind leg reaching to the nostril; while in the other form it scarcely touches the orbit. While I am here tentatively regarding the two as synonyms, I consider the matter still unsettled.

The habitat of the species is usually along pools or streams. Individuals may be seen perched on rocks amidstream or at the edge of the water. When disturbed on land they run to the water, swim to some rock if one is near or dive under the water and emerge at some point some distance away.

The Costa Rican material available to me consists of the following specimens. Limón Province: KUMNH Nos. 34163-34166, 34259-34260, Los Diamantes, Guápiles; 40581-82, Suretka; 34155, 34261-62, 34268, Moravia de Chirripó; 34162, 34265, La Lola. Cartago Province: 25652-54, 34258, La Suiza; 34153-54, 34157-61, Turrialba. Heredia Province: 25656-59, 34156, 40579, Isla Bonita. Guanacaste Province: 40580, 4 to 5 km. ENE Tilarán; 34167, 4 mi. NW Tenorio, Las Cañas. San José Province: 25655, 2 mi. SW San Isidro del General; 34263, 9 mi. west San Isidro del General on Dominical road (possibly in Puntarenas Province).

I propose to fix or restrict the type locality of *A. oxylophus* Cope to Sipurio, Limón Province, C. R.

*Anolis aquaticus** sp. nov.

(Fig. 39)

Type: KUMNH No. 34276, Palmar, Puntarenas Province, Sept. 3, 1953; John Baker, Coll.

Paratypes: KUMNH Nos. 34277, 34278, Golfito, Puntarenas Province; Edward H. Taylor Coll.

Diagnosis: A whitish line on upper lip running back and above tympanum meeting its fellow on nuchal line; a light line from mouth angle to groin; tail strongly compressed, triangular in cross-section; a median row of enlarged serrate scales on tail; two larger median rows of scales on back; ventral scales strongly keeled; semicircular ridges strongly pronounced, the enlarged scales reaching canthus, but the ridges do not; the suboculars separated from the supralabials by two (or three) scalerows; three or four scalerows between the supraorbital semicircles; three irregular rows of keeled supraoculars; ear-opening large, only slightly smaller than eye-opening; a strong axillary depression; tail annulated to tip; body with lateral dark brown bars, dim on median line, separated by lighter tan transverse marks; male with large orange-colored dewlap.

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* From Latin *aquaticus,* living in or near water.

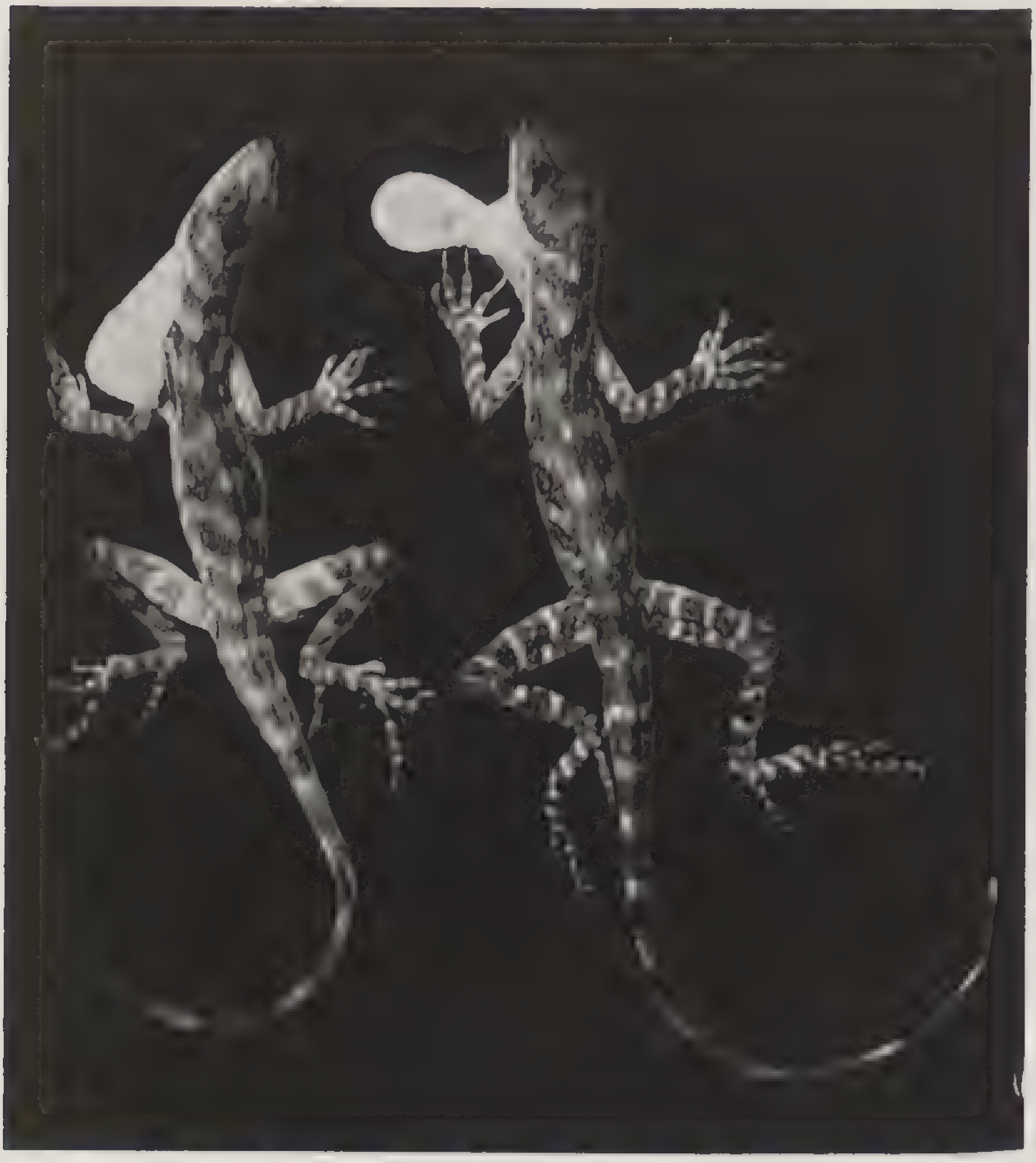

FIG. 39. *Anolis aquaticus* sp. nov. Left figure, KUMNH No. 34277 ♂, Golfito, Puntarenas Province, C. R.; actual length, snout to vent, 61 mm.; right figure, type, Palmar, Puntarenas Province, C. R.

Description of type: Rostral about three times as wide as high, its labial border distinctly less than that of mental, and bordered behind by eight small scales, separated from scales surrounding nostril by two scalerows; five small scales around nostril; seven supralabials, each with a longitudinal keel; circumorbital semicircular ridges curved posteriorly, then running nearly straight forward, terminating on forehead, but large scales of series continuing to canthal edge, these often with several transverse ridges or keels; occipital scale a nearly perfect oval bearing "eyespot," about half size of tympanum, separated from enlarged scales of ridges by about six scalerows, the area surrounding scale flattened and on about the same level as the depression between ridges which continues to beginning of elevated part of snout; scales on snout ridged or keeled, on forehead, less so; supraoculars in about three irregular rows, the inner row largest, all with one or more keels, the group surrounded by fine granules but only one row separating inner supraoculars from ridges.

Canthal series begins above eye, the first two scales very small, followed by a distinct row of four large keeled canthals, the keels forming nearly a straight line, terminating some distance behind nostril; a series of eight suboculars bordering lower orbital rim, separated from supralabials by two or three small scalerows; eight enlarged supralabials terminating below middle of eye; posterior border of mouth bordered by minute granules; mental a little more than twice as wide as long with a median suture entering from behind, almost completely segmenting the scale; infralabials nine, extending back a little farther than supralabials; ten or eleven rows of scales in loreal area; four or five rows of scales lying along infralabials, slightly enlarged but no distinguishably enlarged row; six scales border the mental besides the labials, the two outer a little larger than others.

Occiput covered with fine granules, smaller than those surrounding occipital; two median rows of scales somewhat enlarged, the 20 succeeding lateral rows smaller or some may be larger laterally, all distinctly larger than the granules on sides; about 140 scales about body; ventral scales much larger than dorsal scales, imbricate, keeled, the largest ones on sides of dewlap; no enlarged postanal scutes; two median rows of subcaudals largest, strongly keeled; median dorsal caudal row enlarged, not or but slightly serrate; all caudal scales keeled; tail segments number 29, eight whorls of scales to a segment; largest scales on arms and legs about size of median dorsals; 16 widened lamellae under the two longest toes;

under the terminal joints, ten or eleven; 23 widened lamellae under longest toe; eleven lamellae under terminal joint of same toe, totalling 34 lamellae in all. Tympanum vertically oval, 2.2 mm. x 1.4 mm.; depth of dewlap equal to length from tip of snout to arm insertion; tail compressed, triangular in cross-section; length of tibia equals or slightly exceeds head length; no enlarged scales on eyelid.

Color in life: Above olive to olive-brown; back with a series of seven dark transverse bands, laced with cream, which become less distinct dorsally; a median dorsal row of light marks; head olive brown; a broad cream line from snout tip, involving most of tympanum, joins its fellow on median nuchal line; a light cream stripe from jaw angle above arm to groin, and bordered below by a series of narrow blackish diagonal lines bearing a few cream dots, and separated by diagonal cream lines; arms, legs, and digits banded with fawn or cream; chin, and most of venter cream-white with some little yellow; dewlap orange. Tail banded with broad brown bands separated by olive, the dark bands growing wider posteriorly; a dark band on the infralabials; under side of limbs cream white.

Measurements in mm. (KUMNH Nos. 34276 ♂, 34277 ♂, 34278 ♀ respectively): Snout to vent, 65, 61, 54; tail, 97, —, 90; length of head, 18.2, 17, 15; width of head, 10.5, 10.2, 9.8; snout to ear, 16, 15, 14; snout to arm insertion, 25, 24, 21; axilla to groin, 28, 26.7, 24.4; arm, 29, 29, 27; leg, 53, 51, 44; tibia, 18.5, 17.2, 14.5.

Remarks: The narrow diagonal dark lines low on the sides are separated by narrow cream lines of equal width and the dark lines themselves have rows of small cream dots. The female has no dewlap. The axillary depression is less conspicuous in the two paratypic specimens.

The type is from Palmar, the other two (34277-78) are from Golfito. All were taken at night, presumably asleep, clinging to boulders in rivulets just above the water. Certain others seen during the day escaped by diving and hiding below water. The figures are of the two male specimens; that on the right is the type.

One suspects that the relationship of the form is with *lionotus*. They agree in being semiaquatic in habit, each has a cream lateral line, and an orange dewlap. The differences are that *lionotus* has dorsal scales that are larger (nearly double the size) and instead of being keeled are smooth; the dorsum is flattened rather than compressed, and the tail is less strongly compressed than in the form at hand.

From Cope's *Anolis oxylophus* there is also some similarity in the lateral line extending from the scapular region to near the groin and in having the dorsal scales keeled. In the middle of the back there are certain median rows a little larger than the others (equal to ventrals) but the adjoining 16 rows are larger than the lower lateral scales with considerable irregularity among themselves. Differences in coloration markings are striking. It would appear that both are semiaquatic. The auricular opening is approximately only half as large as in the described form.

Anolis pachypus Cope

Anolis pachypus Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1876 (1875), pp. 123-124, pl. 24, fig. 3, (type locality "slope of Pico Blanco," Limón Province, Costa Rica, William Gabb, coll.); Boulenger, Catalogue of the lizards in the British Museum, 2nd Ed. vol. 2, 1885, pp. 63-64 (copied description); Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Oct., 1885, p. 47 (no specimens); Dunn, Proc. New England Zool. Club, vol. 12, 1930, p. 16 (Volcán Barba C. R.; places *A. curtus* and *A. tropidolepis* in synonymy); Barbour, Bull. Mus. Comp. Zoology, Harvard Col., vol. 77, no. 4, 1935, pp. 144-145; Wettstein Sitzungsb. Akad. Wiss., Wien, Math-natur. Kl., Abt. 1, Band, 143, Heft, 1 and 2, 1934, p. 20 (Volcán Irazú, Volcán Poás, Bebedero, San José, La Carpintera. [The report from Bebedero, near sea level is surprising for this species].)

I have no authentic specimen representing this species, in the collections at hand. The type, USNM No. 30683, is in bad condition, since it has been dried and somewhat rotted, the legs are broken off, the mental is missing, and consequently it does not serve for a redescription. Hence I append the data from the original description.

Description of species (Data from type, or type description): Head rather short, its length equalling that of the tibia and one-half greater than its width; supraorbital semicircles composed of scales no larger than the fine series of scales that separate them; no ridges but a depression in occipital region continued between orbits to a rather deep frontal concavity; scales in frontal concavity a little smaller than those which separate them from canthal row; six canthal and supraciliary scales extending to near middle of supraciliary area; supraorbital region covered with projecting granules except a single row of three or four small keeled supraoculars near the supraorbital border; four rows between supraorbital series and occipital scale; eight loreal rows; one series of very small infralabials, the gulars running up to them in longitudinal lines; ear-opening larger than the occipital scale.

Scales of abdomen smooth, those of sides very small, on the back gradually enlarging to two or three largest and faintly keeled rows on the median line which are much smaller than those on venter. Scales on top of head subequal in front, keeled; smaller and angular behind, covering a three-sided area behind the orbits, which is abruptly distinguished from the minute granules of the temples and nape.

The feet are stout and clumsy; the wrist reaches to the front of orbit; third toe of hind limb reaches end of muzzle. The digital dilations are little or not more expanded distally than proximally and the distal joints are covered with wide keeled scales above; gular fan well developed.

Tail cylindrical with equal scales, swollen at base.

Color: Emerald-green with a broad brown band from orbit to middle of side, and a narrower one on each side of sacrum. A green band from orbit to below tympanum, and a dark-brown band from orbit below canthus rostralis; a dark-brown cross-band between the supraciliary borders across frontal area; a deep brown spot behind occipit, and a smaller one on the nape; femur with a longitudinal black band behind, and an oblique one across the superior face; tibia and forearm with a broad cross-band.

Measurements in mm.: Total length, 135; snout to vent, 47; snout to axilla, 20; snout to tympanum, 11; arm, 22; hand, 9; leg, 43; foot, 19; tibia, 12.

Remarks: Until sufficient new material from the Pico Blanco area is available there will be some doubt about the validity of the distinction of this southern form. The type specimens from an unknown elevation on Pico Blanco differ from most Costa Rican specimens available in having the ventrals smooth, and the third toe of the hind foot reaching the end of muzzle. The supraciliaries [= semicircular series] not larger than the scales of the five rows which separate them; a single row of three or four small keeled supraoculars. Its relationship would seem to be with *Anolis tropidolepis* Boulenger.

Anolis tropidolepis Boulenger

(Fig. 40)

Anolis tropidolepis Boulenger, Catalogue of the lizards in the British Museum, 2nd Ed., vol. 2, 1885, p. 53 (type locality Irazú [Volcán?]); Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Oct. 1885, p. 46, pl. 27, fig. C. (figure of type).

Diagnosis: Ventrals keeled; longest toe not reaching nostril or tip of snout; scales of semicircles distinct, polycarinate, separated by from three to five scales; supraoculars numerous in two or more

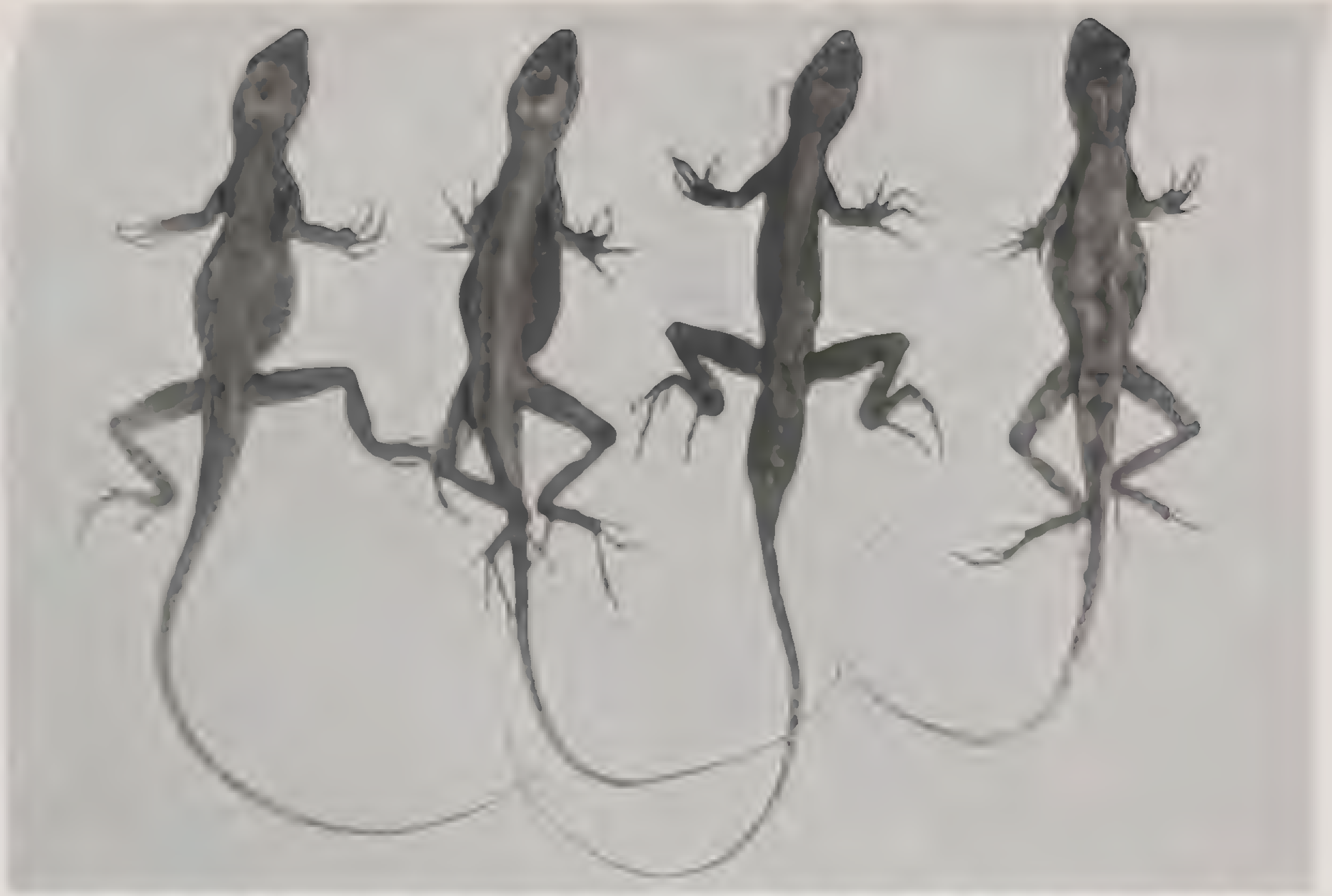

Fig. 40. *Anolis tropidolepis* Boulenger. First figure: KUMNH No. 40711, 8 mi. E Vara Blanca, Heredia Province, C. R., actual length, snout to vent, 51 mm., total length, 122 mm.; second figure: 40078, near Carrizal on Pacific slope of Volcán Barba, actual length, snout to vent, 50 mm., total length, 136 mm.; third figure: 40700, 5 mi. E Vara Blanca, actual length, snout to vent, 49 mm., total length, 148 mm.; fourth figure: 40606, Finca Zeledón, near Vara Blanca, actual length, snout to vent, 49 mm., total 142 mm.

rows; scales of area anterior to supraorbital region with polycarinate scales (two to five keels); head longer than tibia.

Description of subspecies (From KUMNH No. 40730 near Finca Zeledon, near pass between Volcán Poás and Volcán Barba): Rostral three and one-fifth times wider than high, bordered behind by seven rugose postrostrals and two labials; ten scales between nasals, the latter separated from rostral by two scale series; semicircular series begin near inner level of supraocular region, run forward to the canthal edges, separated mesially by four scale series; about 16 scales between canthals; scales of frontal and snout areas with from one to five keels, sometimes more on the semicircle scales anteriorly; three larger, and four or five smaller supraoculars; five rather broadened canthals, the keels not forming a continuous line, continuous with two elongate superciliaries almost completely overlapping each other; these in turn are followed on the posterior supraciliary region by three series of slightly enlarged supraciliaries, the median series largest; nostril surrounded by a single narrow rim strongly overhung by a supranasal; about four enlarged suboculars, one or two touching the labials (usually completely separated from labials); seven or eight supralabials to below middle of eye; nine infralabials; five scale series below infralabials, larger than median rows on chin; eight loreal rows; mental wider than rostral about two and one-half times as wide as high, bordered behind by two labials and six postmentals the two outer largest; scales on sides of throat only slightly enlarged; occipital scale about one third of the size of ear-opening separated from semicircles by four scale series; occipital area slightly depressed bounded behind and laterally by two swollen areas covered with fine granules; scales of temporal region very small, the scales of the upper temporal border not noticably enlarged, ventral scales rather rounded behind, keeled, the scales not flat; scales on side granular but on dorsum becoming somewhat larger; four largest along median line only about half as large as ventrals and rather distinctly keeled; about 160 scales in a row around body; tail broken and partly regenerated. (In another specimen, tail widened at base; tapering suddenly, cylindrical, attenuated; median dorsal scalerow not or scarcely larger than other caudal scales; no enlarged postanals; the postanal depression shallow; gular dewlap in male shorter than head); dewlap not developed in female; ear-opening relatively large, vertically oval, about 1.5 mm. x 1.1 mm.; fingers scarcely widened distally; toes noticeably widened; about twenty-two lamellae and scales under fourth finger; thirty-six under longest toe; arm reaches groin or a little farther; leg reaches to anterior border of orbit; scales on dorsal part of upper arm smaller than those on upper surface of forearm; scales on front face of thigh equal or larger than scales on posterior and ventral surfaces of tibia.

Color: Above generally olive with three or four indefinite narrow brown chevrons across back; a lateral yellowish-brown stripe varying in width and at places marked with dim lighter brown mottling or dim diagonal lines; a greenish-olive stripe from supraciliary

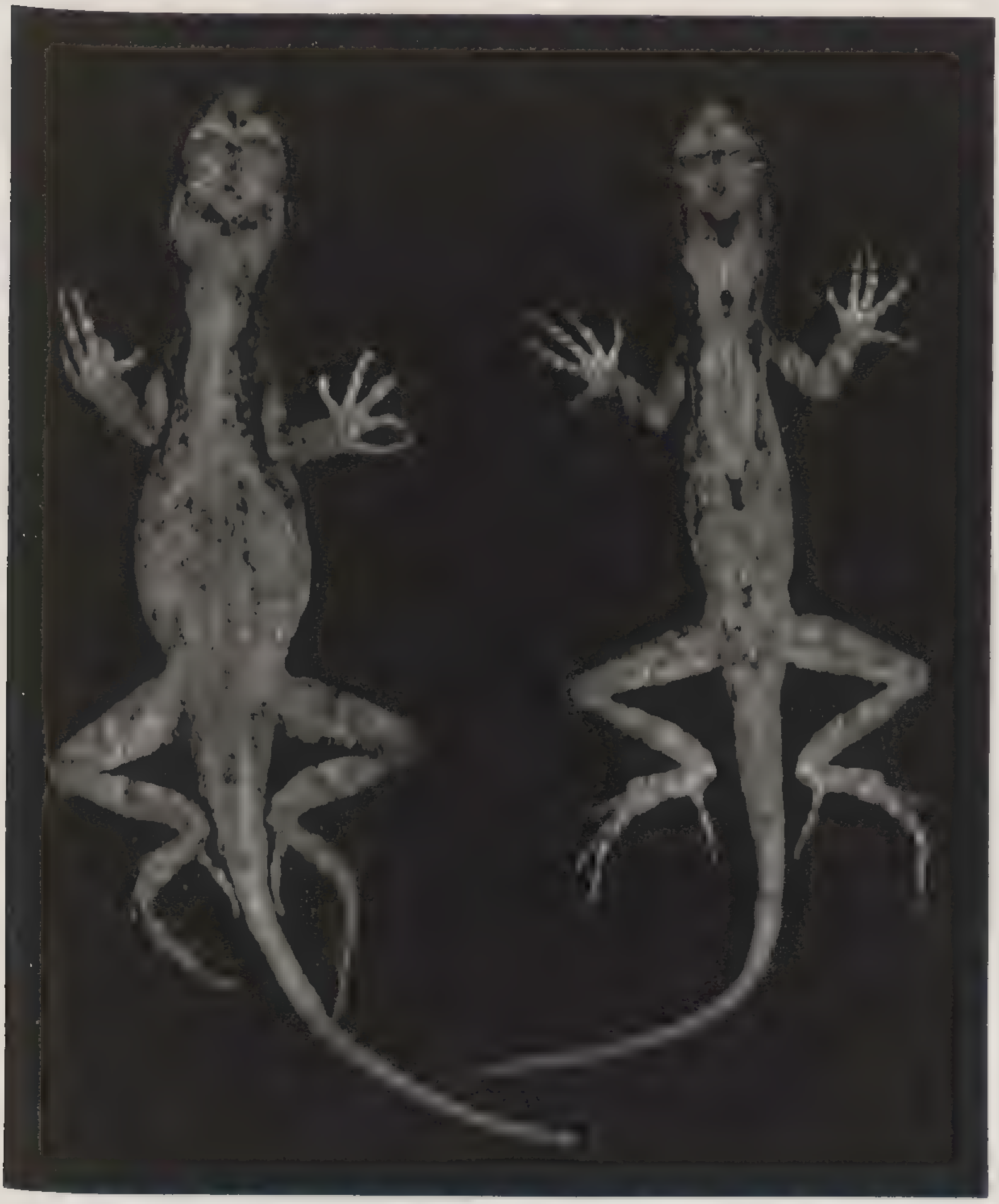

FIG. 41. *Anolis tropidolepis* color var. Left figure, KUMNH No. 40727, 3 mi. E Vara Blanca; actual length, snout to vent, 50 mm.; right figure, 40672, Boquete Camp (2,000 m.) west slope Cerro de la Muerte; actual length, snout to vent, 43.5 mm.

border back onto neck; a similar diagonal line from eye across angle of mouth to foreleg; a greenish-olive mark below eye more or less continuous with similar area along chin below infralabials; venter bronzy yellowish washed with brown; greenish flesh under thigh; chin dirty white; thigh and tibia with a diagonal brown lighter-edged band. Gular appendage in male orange to reddish, somewhat narrow at base; a brown band across head, angular mesially, with a lighter center; front of snout olive.

Measurements in mm.: Nos. 40724 ♀ and 40704 ♂. Snout to vent, 50; 46; tail, reg., —; 78; snout to ear, 13.7; 11.8; snout to leg insertion, 19.4; 18; axilla to groin, 22; 19; head length, 16; 14; head width, 9.8; 8.8; arm, 24; 21; leg, 42; 39; tibia, 12; 11.8.

Variation: The color changes are rapid. In preservation the specimens show considerable variety of patterns. Females often have a very narrow dark line or stripe on the median dorsal line connecting with a black occipital spot; when this is present there are no head bands and the lateral brown stripe may be obsolete.

Bodies of males are distinctly compressed and the dewlap is usually purplish red in life. There is considerable variation in the character of the scales of the semicircular series. Rarely one subocular may touch the labials. Specimens from the northern part of the Talamanca range (along the Pan-American Highway) the semicircles are largest and most strongly keeled. The series from Heredia Province north of the Cordillera Central have the scales small with a lesser amount of keeling, and separated by more scale rows.

Remarks: Specimens occur only at relatively high elevation. I have taken them from about 5,000 to 8,000 feet. They are likely to be on the ground or near the ground on tree trunks. In Heredia Province many were found about or on stumps six to eight feet high on which many plants were growing.

The following specimens have been collected. Cartago Province: KUMNH No. 40674, Quebrada Onda; 40681, 40683, Pacayas; 40687-89 Finca Quirazú. San José Province: 40714-40719, La Carpintera; 40681, 40682, near Empalme, south of Cartago; 40675-40676, National Forest on Pan-Amer. Highway south of Cartago, 6,000-7,000 ft. elev.; 40672, Boquete Camp 2,000 m. west slope Cerro de la Muerte, 40677, south slope Irazú northeast of San José. Heredia Province: 40698-40713, 40722-40725, 40726-40734, Vara Blanca and vicinity; 40794-40797, Finca Zeledón near pass between Volcán Poás and Volcán Barba; 40678, near Carizal; 40679-80, Finca Montechristo.

Anolis curtus Boulenger

(Fig. 42)

Anolis curtus Boulenger, Proc. Zool. Soc. London Nov. 29, 1898, p. 919, pl. 55, fig. 2, 2a (type locality La Estrella, Cartago, Cartago Province, Costa Rica, C. F. Underwood Coll.).

Diagnosis: Head a little longer than tibia; frontal ridges low, or obsolete, the scales of the semicircles rather small, separated mesially by from five to seven scale series; eight loreal series; occipital smaller than ear-opening, separated from semicircles by six series of scales; gular dewlap very small; mental divided by a groove; two rows of scales between small suboculars and supralabials; two bands of brown across head (in males); tail much inflated at base, then suddenly slender, cylindrical; length, snout to vent, 51 mm.

Description of species (From KUMNH No. 4837, Finca Montechristo, Volcán Barba, circa 5,800 ft.): Rostral not or scarcely visible from above, about four to five times as wide as high, followed by two supralabials and eight small scales; rostral separated from nasal by three scale series; nine scales between nostrils; no distinct ridges, the semicircles composed of somewhat enlarged multikeeled scales, larger however than surrounding scales, the series reaching canthus; anteriorly they are separated by about ten series of scales at narrowest part by five or six scale series; supraciliaries rather small except two anterior; these preceded by six narrow subequal canthal scales, their outer edges not forming a continuous edge; about eight loreal series; a series of six or seven small suboculars, separated from the labials by two rows of scales; ninth supralabial and eighth infralabial below middle of eye; supraoculars small, irregular in size in about four rows; all smaller than adjoining circumorbital series, and separated from those scales by a row of granules; occipital enlarged but smaller than the auricular opening, separated from the semicircles by five or six scale series; occipital area very slightly depressed; temporal area covered with very small granular scales; five or six somewhat enlarged scale series bordering the infralabials; mental divided by a deep groove into two triangular moieties, the rostral border greater than that of mental; two labials and six postmentals border mental; auricular opening vertically oval (1.4 mm. x .8); no nuchal crest or fold; about four dorsal scalerows larger than the laterals but there is no strong line of demarcation, since they gradually merge into the fine granules of the sides; approximately 148 rows of scales and granules about body; ventral scales small, thin, larger than largest dorsal scales, keeled, imbricating, in about 22 rows, however there is no defined

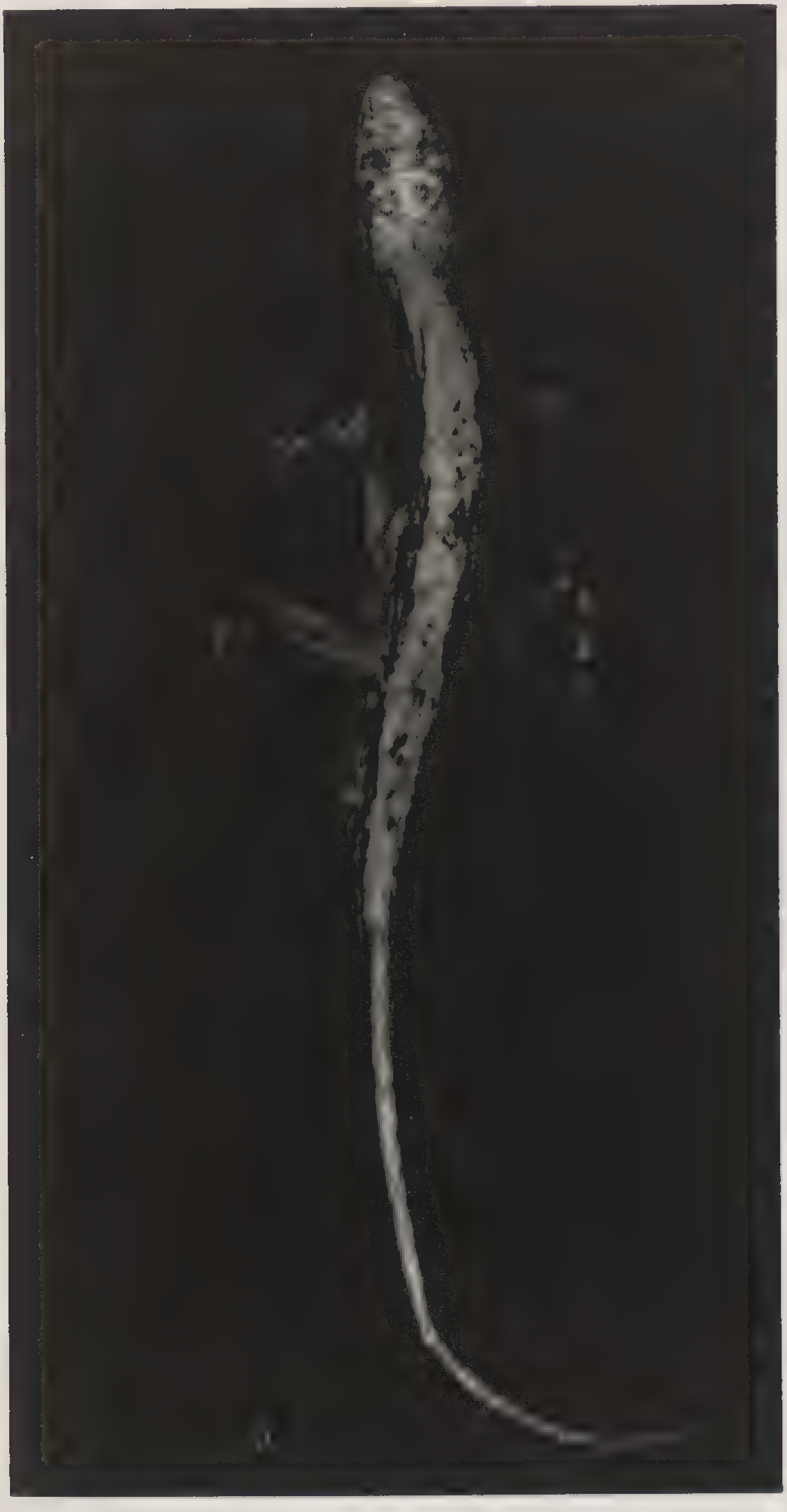

FIG. 42. *Anolis curtus* Boulenger. KUMNH No. 4837, Finca Montechristo, Volcán Barba, circa 5,800 ft. Actual length, snout to vent, 49 mm.; total length, 126 mm.

line of demarcation; caudal scales keeled, the median dorsal row not serrate, the two ventral rows larger than the median dorsal row; postanal depression without distinctly enlarged postanals; scales on top of upper arm, front of forearm, and front of thigh much enlarged; scales of under side of tibia larger than other tibial scales; longest toe reaches to near nostril; postanal region strongly inflated, behind which the tail tapers suddenly; thirty three lamellae and scales under fourth toe; under middle fingers 22-24.

Measurements in mm.: No. 4837 and Type. Snout to vent, 49, 51; tail, 77, 56 regenerated?; total length, 126, 107; snout to ear, 12.2, —; snout to foreleg, 21.6, —; length of head 15.2, 15; width of head, 8.7, 9; axilla to groin 20.5, —; arm 22, 21; leg, 40, 39; tibia 12.2, —.

Color in life: Above generally brown lacking a stripe but with a frosted silvery region on dorsum from occiput to tail with some fine black flecks, more distinct on tail (type has black marks all along median line of back); top of head silvery with metallic reflections, lighter in the depressed area of head and on tip of snout; labials yellowish or cream; chin and gular appendage dark olive brown; belly heavily pigmented and with bluish or greenish metallic reflections; tail gray brown with some lighter flecks along the dorsal part; extreme tip regenerated, deep black; an indefinite dark mark on thigh and a band on tibia.

Remarks: This specimen taken in the same area with *Anolis tropidolepis* shows some similarities to that species. The differences however, appear to outweigh the similarities. Boulenger named this form *curtus,* but I strongly suspect the tail of the type specimen is regenerated, thus incomplete—hence the apparent difference in actual length. However the reduced size of the suboculars separated by two scalerows from labials instead of one, six instead of four canthals that are distinctly narrower, five to seven instead of three or four scale series between semicircles, smaller and more numerous supraoculars, all point to a species or subspecies differing from *tropidolepis.*

Anolis achilles * sp. nov.

(Fig. 43)

Type. KUMNH No. 40634 La Palma, San José Province, C. R., June 20, 1954. Edward H. Taylor, Coll.

Diagnosis: A small anole characterized as follows: sixth or seventh supralabial and sixth infralabial below middle of eye; five suboculars in contact with the supralabials; six loreal series; tail with a dorsal row of moderately enlarged supracaudals, not serrate, the tail very slightly compressed; head much longer than tibia; longest toe reaching ear; about 130 scales and granules around middle of body; semicircles consisting of seven or eight large scales reaching canthal edge, separated mesially by one row of scales; only largest supraocular touches the semicircle, in contact with two or three scales; posterior supraciliary scales not differentiated; seven or eight median dorsal scalerows slightly enlarged, but not half as large as ventral scales; a few much enlarged scales on heel, two to three times larger than adjoining scales.

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* Referring to the Greek hero, Achilles who had a specialized heel.

Description of type: Rostral two and one-half times as wide as high, bordered behind by two labials, four postrostrals and seemingly by the two nasals; six scales between the two nasals on snout; semicircles consist of seven scales the fourth normally largest, the series terminating anteriorly with the anterior canthal, the individual scales of the series keeled, and anteriorly they are also somewhat rugose, between orbits separated by a single series of small scales, anteriorly separated by seven scales.

Scales on snout keeled, the scale edges are often elevated suggesting a tricarinate condition; three keeled canthals relatively wide and rugose, the outer keel forming a rather sharp edge; anterior supraciliary scarcely longer than median canthal, but overlapping a small second supraciliary; about half of supraciliary border covered with fine granules; occipital scale about two and one-half times area of ear-opening, separated from semicircles by two scalerows; supraoculars in two rows, the inner curved, consisting of four scales; all except largest supraocular separated from the semicircles by small granular scales; second row of three scales; six (or five) loreal series; five suboculars strongly enlarged, the largest almost touching the labial border; seven (or eight) supralabials, the sixth or seventh below middle of eye; the scales elevated on their lower border; seven infralabials, the sixth below middle of eye; mental with a considerably larger labial border than the rostral, divided by a groove for three fourths of its height, the height in width two and one-half times; the whole scale bordered by two labials and six postmentals, the two outer enlarged; four rows of scales below infralabials somewhat enlarged, rugose or keeled; ear-opening subtriangular; ventral scales dimly keeled in about twenty rows, gradually merging into small lateral granules which, as they approach the dorsal line, are again slightly enlarged, the two median discernibly the largest; no medial ridge; no axillary pockets; body slightly compressed; relatively large calcium deposits present behind ear (possibly somewhat abnormal); limbs short; the lamellae under digits widened, except on distal part; lamellae and scales under fourth finger, 14 + 7; under fourth toe, 24 + 8; scales on upper arm, on front and dorsal surfaces scarcely more than half as large as those on the front of the forearm, where they are as large as ventrals; scales on front of thigh essentially as large as those on tibia often with two, rarely more, keels; scales on under side of heel two to three times the size of adjoining scales bearing four to six low keels; longest toe reaches ear; hand brought forward, the

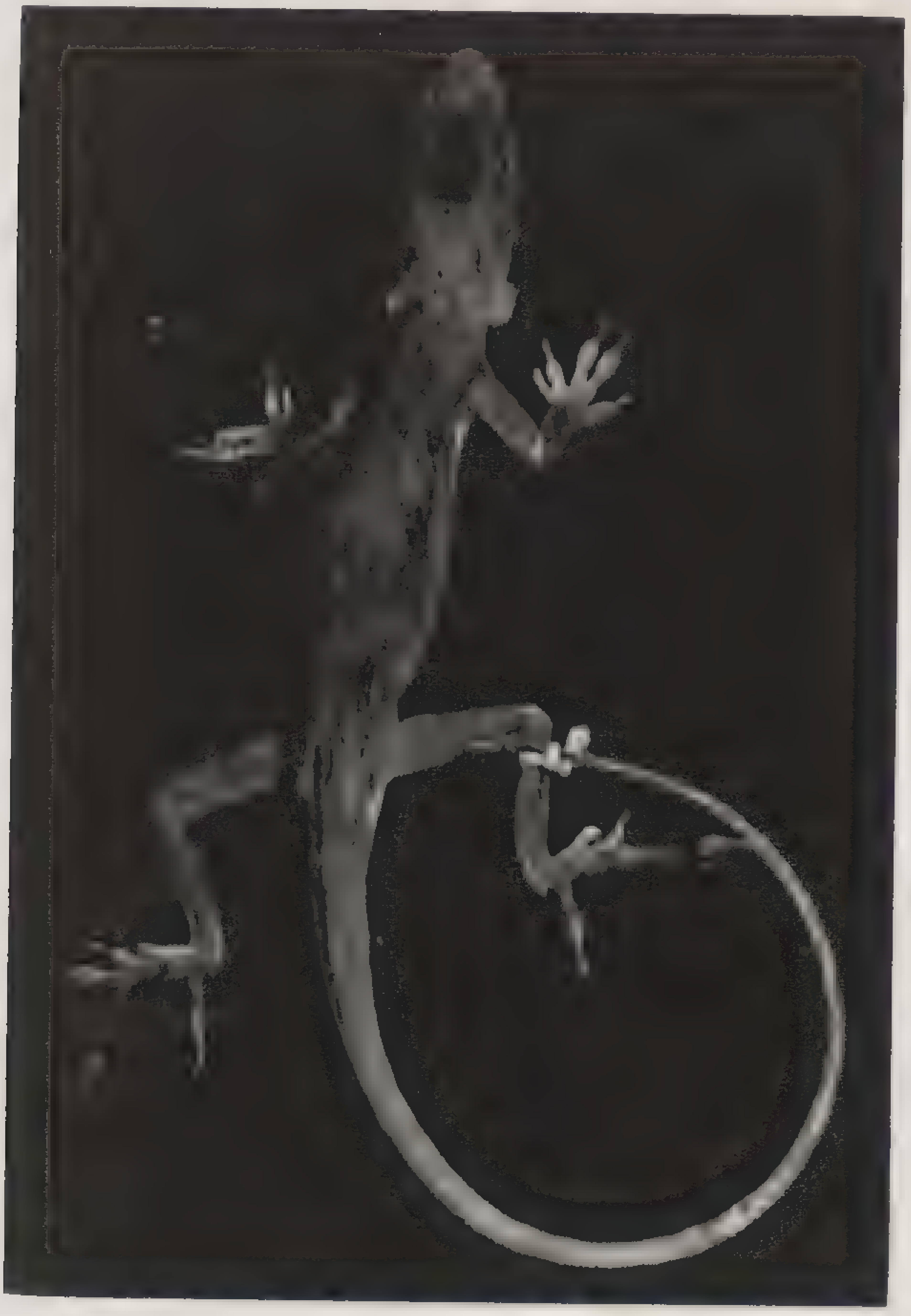

FIG. 43. *Anolis achilles* sp. nov. KUMNH No. 40634 ♀, type; La Palma, San José Province, C. R.; actual length, snout to vent, 45 mm.; tail, 77 mm.

longest finger fails to reach the tip of the snout; dorsal caudal row somewhat enlarged, not serrate; two ventral rows larger, all keeled; tail subcircular or slightly compressed.

Color: The female specimen preserved in formalin is, save for a few brownish flecks, nearly unicolor dorsally; on the side, however, there is a distinguishable lighter stripe bordered above and below by a brown line; the forearm is dimly banded with brown and the hind limb shows some darker brown flecks on the dorsal surface, and there is slight evidence of darker and lighter areas on the latter half of the tail; under side of tail lavender; ventral surfaces of body and head dull white with scattered pigment; occipital region blackish.

Measurements in mm.: Snout to vent, 45; tail, 77; total length, 122; snout to ear, 11; snout to arm insertion, 19; axilla to groin, 19; head width, 7.3; head length, 13.1; arm, 18; leg, 31; tibia, 10.

Remarks: Only a single specimen was taken. The presence of the widened heel plates has not been discerned in other species of the genus. The presence of the enlarged visible auricular deposits of calcium is of common occurrence in the Gekkonidae and Sphaerodactylidae. It is of less frequent occurence in Costa Rican Iguanidae.

Anolis godmani Boulenger

Anolis godmani Boulenger, Catalogue of the lizards in the British Museum, 2nd Ed., vol. 2, 1885, pp. 85-86 (type locality Guatemala* and Irazú Costa Rica [here restricted to Volcàn Irazú, Costa Rica]); Cope, U. S. Nat. Mus. Bull. 32, p. 31 (listed); Dunn, Proc. New England Zool. Club, vol. 12, Aug. 7, 1930, p. 20 (seemingly regarded this as a synonym of *Anolis limifrons,* regardless of its keeled ventral scales).

Diagnosis: Ventrals keeled; head slightly longer than tibia; upper head scales very small, uni- or tricarinate; semicircles separated by two to four scales; occipital larger than ear-opening, separated from semicircles by from three to five scales; loreal rows six to eight; dorsal scales very small, subrhomboidal, keeled; ventrals larger, roundish-hexagonal, imbricate; hind leg reaches nearly to end of snout; tail cylindrical, nearly twice head-body length; no enlarged dorsal caudal series; upper lip yellow, bordered above by a sharply defined brown band passing through eye and above ear; crossband between eyes.

Description of species (From type description): "Head once and three fourths or twice as long as broad slightly longer than tibia;

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* Stuart (1955) seemingly disregards Boulenger's record of the species for Guatemala.

snout rather pointed; forehead and interorbital region concave; frontal ridges short and divergent; upper head scales very small, uni- or tricarinate; scales of the supraorbital semicircles enlarged, separated by two to four series of scales; a few enlarged, keeled supraocular scales; occipital larger than the ear-opening, separated from the supraorbitals by three to five series of scales; canthus rostralis sharp, canthal scales three or four; loreal rows six to eight; six upper labials to below the centre of the eye; ear-opening moderate, vertically oval; gular appendage moderate; gular scales keeled. Body not or scarcely compressed; no dorso-nuchal fold; dorsal scales very small, subrhomboidal, keeled, graduating into the minute granules of the sides; ventrals larger, roundish-hexagonal, imbricate, keeled. Limbs slender; the adpressed hind limb reaches nearly the end of the snout; digits feebly dilated; thirteen or fourteen lamellae under phalanges II and III of the fourth toe. Tail cylindrical, nearly twice as long as head and body, without vertebral series of enlarged scales. Greenish-brown above; upper lip yellowish, bordered above by a sharply defined brown band passing through the eye and above the ear, vanishing behind the shoulder; a dark cross band between the eyes; sometimes a few small distant brown spots on the vertebral line." Total length, 107 mm.; head, 12; width of head, 6; body, 26; forelimb, 16; hind limb, 34; tibia, 11; tail, 69.

Remarks: Boulenger had four Guatemala specimens (male and halfgrown), and three from Irazú, Costa Rica (male and female), in his type series of *A. godmani.* The species agrees fairly well with *limifrons* in many of its characters. One presumes that it is a mountain form while *limifrons* is a lowland form probably not occurring much above 2,000 ft. elevation. The exact elevation from which the types of *godmani* were obtained is not recorded but it is safe to believe that they came from above 5,000 ft. This species has been omitted from the key.

I propose to restrict the type locality to Volcán Irazú, C. R.

Genus POLYCHRUS Cuvier

Polychrus Cuvier, Règne Animal, vol. 2, 1st ed. 1817, p. 40 (type of genus *Lacerta marmorata*).

Diagnosis: Body compressed, lacking both nuchal and dorsal crests; head scales somewhat enlarged; body covered with small imbricating scales; no gular fold; gular sac in males; tympanum distinct; femoral pores present in both sexes; digits compressed with subdigital lamellae carinate; four large scales near the base of the claw; tail much elongate, nearly circular in cross-section. Pterygoid teeth present; lateral teeth tricuspid; abdominal ribs present.

A single species is recognized in Costa Rica, present on both the Caribbean and Pacific slopes of the country. It remains rare in collections.

Polychrus gutturosus Berthold

(Fig. 44)

Polychrus gutturosus Berthold, Abh. Ges. Wiss. Göttingen, vol. 3, 1847, p. 5, pl. 1, fig. 1 (type locality, Colombia); Boulenger, Catalogue of the lizards in the British Museum, 2nd Ed. vol. 2, 1885, p. 100 (Colombia and Costa Rica); Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1876 (1875), p. 124; U. S. Nat. Mus. Bull. 32, 1887, p. 32: Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Oct. 1885, p. 53.

Polychrus (Chaunolaemus) multicarinatus Peters, Mon. Akad. Wiss. Berlin, 1869, p. 786 (type locality, Costa Rica); Bocourt, Mission Scientifique au Mexique et dans l'Amérique Central; Étude sur les Reptiles, livr. 2 and 3, 1873, 1874,* p. 112, pl. 17, fig. 8.

Diagnosis: Lateral scales smaller than dorsals or ventrals; no longitudinal serrated ridge on front of throat; ventral scales multicarinate (two to six) smaller than the gulars; semicircular supraorbital series larger than other supraorbital scales, but smaller than scales on snout.

Description of species (From KUMNH No. 25170): Body compressed, somewhat triangular in cross-section; head angular, with a sharp canthus rostralis and a sharp ridge above and following eye; rostral low, its width about two and one-half times its height; bordered behind by two median striated scales, two labials and one scale in front of nasal; semicircular series in supraorbital region consist of nine scales on left, ten on right side, separated mesially by a single row of scales; supraoculars in about five rows, the inner scales larger than outer; eight supraciliaries; five larger scales on the temporal ridge; nostril in a single nasal separated by a single scale from rostral, equidistant between eye and tip of snout; a supranasal; frontonasal broken into three parts; ten or more scales in the frontal area, somewhat symmetrical; occipital scales smaller than those on snout, the "occipital" scale somewhat elongated bearing an indistinct "eye"; scales on snout and supraorbital region striate, while in occipital region scales almost or completely lacking striations; three canthals between eye and nostril; six or more scales in loreal region; preocular, subocular, and postocular series continuous, small, totaling 14 scales; a second larger subocular series just above labials; about eight rows of scales in temporal series; supralabials

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* The second page of this description was published in the third livraison which appeared in 1874.

9-9; infralabials 8-8; mental having as wide a labial border as rostral but smaller; a suture enters mental from behind; a pair of enlarged postmentals followed by four scales; scales of the gular pouch smooth, separated by soft granules; nostril equidistant between eye and snout-tip; scales on head, chin and lips with numerous striations or low irregular keels; scales of middle ten rows of body larger than laterals, with one or more keels; lateral scales imbricating, oval

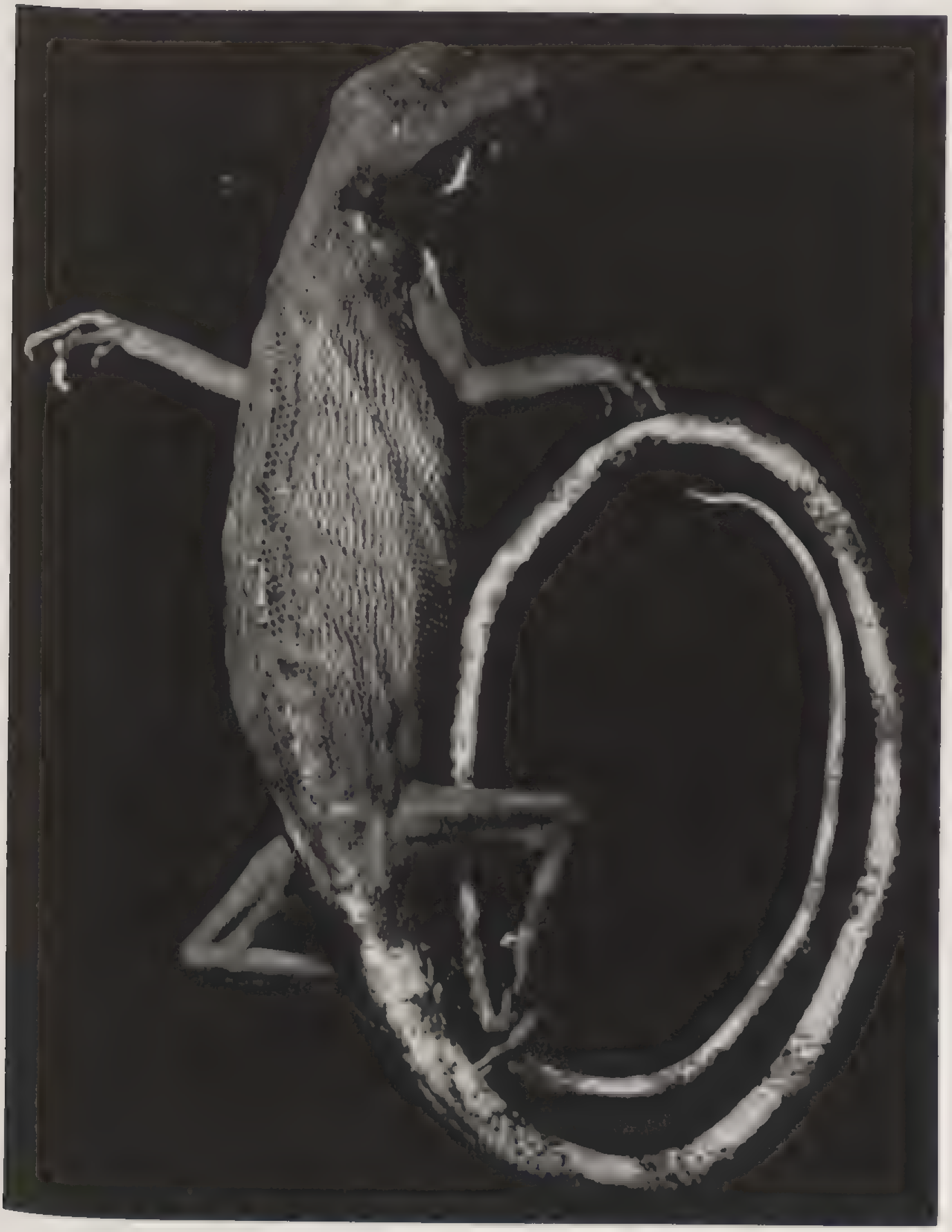

FIG. 44. *Polychrus gutturosus* Peters. KUMNH No. 25170, Turrialba, Cartago Province, C. R.; actual length, snout to vent, 163 mm., total length, 685 mm.

or pointed posteriorly, usually with a single keel and usually pointing back and somewhat downward; lower on side scales with more than a single keel; ventral scales usually with two to five keels, larger than the lateral scales; scales on posterior face of femur with a single keel, elsewhere with two or more; scales of the tail strongly imbricating, larger than body scales, with a single sharply defined keel.

Limbs slender, the digits compressed, the third and fourth fingers nearly of equal length as are the third and fourth toes; claws angular; base of claw surrounded by a large dorsal and three other scales; subdigital lamellae or scales widened, with numerous keels. Hind leg brought forward, the longest toes reach axilla or slightly beyond; anal flap semicircular, its scales a little larger than the scales that precede them. Femoral pores in female small, the inner ones somewhat enlarged, the ten outer scarcely perforating the scales; tympanum distinct; auricular opening usually smaller than eye opening; a few projecting lobules in front of auricular opening.

Color in preservative: Head and body purplish brown but darker on sides of head below and behind eye; a white spot preceded by a darker spot on upper lip; a cream diagonal line from eye to angle of mouth and a cream spot below mouth angle; a cream stripe low on shoulder passes onto the base of arm. A broad irregular cream stripe from axilla to groin, continued on front of thigh as a line or series of cream flecks; a cream spot or stripe barely indicated at base of tail, but none on back of femur; skin between gular scales bluish (?); venter purplish brown; tail light yellowish-tan with about twenty indistinct darker bands suggested.

Measurements of Polychrus gutturosus

	25170	70660	*
Total length	685	583	—
Snout to vent	163	133	153
Tail	522	450	338+
Length of head	38	32	35
Width of head	27	27	22
Arm	61	—	63
Leg	85	—	78
Tibia	25	—	—
4th finger	16	—	14
4th toe	21	—	20

* Type of Peter's *Polychrus (C.) multicarinata.* KUMNH No. 25170, Turrialba, Costa Rica; USNM No. 70660, Tilarán, Guanacaste, Costa Rica.

Variation: The small number of specimens that have been examined tells little regarding variation. The color markings of this specimen described (Turrialba, Costa Rica) differs from "*multi-*

carinata" of Peters in lacking the stripe of yellow on the posterior side of the femur, and the olive yellow venter. It does have a broad irregular cream stripe from axilla to groin on the outer ventral surface, with a broad purplish-brown median area from chin to vent.

A specimen in the U. S. National Museum from Tilarán, Guanacaste has a cream stripe six scales wide, from occiput to tail. It is brownish on the sides, and below this a bluish olive. The tail is light with elongate darker spots alternating on each side.

In the latter specimen there are 32 lamellae under the fourth finger, 44 lamellae under fourth toe. The specimen figured is a female containing four ovarian eggs in the right, five in the left ovary. These are nearly spherical and measure 12 mm. in diameter. The tail is 3.2 times the head-body length probably exceeding that of other lizards in proportionate length.

The stomach contents consist chiefly of insect remains with a meager portion of vegetable matter ingested, perhaps accidentally.

Corythophanes Boie

Corytophanes (*sic*) Boie *in* Schlegel, Isis von Oken, vol. 20, pt. 3, 1826, p. 290 (type of genus *Agama cristata* Merrem).

Chamaeleopsis Wiegmann, *in* Gray, *in* Griffith, The Animal Kingdom . . . by Baron Cuvier . . . vol. 9, 1831, Synopsis, p. 45 (type, *Chamaeleopsis hernandesii* Wiegmann).

Diagnosis: "Tympanum distinct. Head with two sharp ridges uniting posteriorly into an elevated bony crest directed upwards and backwards; a bony supraorbital arch formed by the prae- and postfrontal. Body compressed, covered with imbricate smooth or keeled scales; a nuchal crest, attached to the cranial crest; a low dorsal crest. A gular pouch and a transverse gular fold. Infradigital lamellae keeled. No femoral pores. Tail long, feebly compressed. Lateral teeth tricuspid; pterygoid teeth. No sternal fontanelle. No abdominal ribs." [from Boulenger, Cat. vol. II, p. 101.]

A single species of this genus is known in Costa Rica, its range extending from Mexico to Panamá.

Corythophanes cristatus Merrem

(Fig. 45)

Agama cristata Merrem, Tentamen systematis amphibiorum . . ., Marburg 1820, p. 50 (type locality "Ceylon", *ex errore;* restricted to Orizaba, Veracruz, by Smith and Taylor).

Corythophanes cristatus Gray, *in* Griffith, the Animal Kingdom, . . . by Baron Cuvier, Synopsis 1831, p. 55 (*Cytophanes* (*sic*) and *Cyrtophanes* (*sic*); Gravenhorst, Acta Acad. Leop.-Carol., vol. 16, pt. 2, 1833, p. 938, pl. 65, figs. 6-10; Wiegmann, Herpetologia Mexicana 1834, p. 15; Duméril and Bibron, Erpétologie Générale, vol. 4, 1837, p. 174; Fitzinger, Systema Reptilium, 1843, p. 52; Gray, Catalogue of the specimens of lizards in the collection of the British Museum, 1845, p. 194 ("inhab. Mexico"); Duméril, and Duméril, Catalogue Méthodique, Museum Paris, 1851, p. 60 (Peten specimens); Duméril, Arch. Mus. Hist. Nat. Paris, vol. 8, 1856, p. 517; Bocourt, Mission Scientifique au Mexique et dans l'Amérique Centrale; Études sur les reptiles, livr. 3, 1874, pp. 118-119 (Peten specimens); Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1876, (1875) p. 124 (Sipurio, Costa Rica); *idem. ibid.*, p. 156 (Buhio Soldado, Panamá); Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Oct. 1885, p. 53 (Guatemala, Costa Rica, Panamá); Boulenger, Catalogue of the lizards in the British Museum, 2nd Ed., vol. 2, 1885, pp. 101-102 (Guatemala to Costa Rica); Cope, U. S. Nat. Mus. Bull. 32, 1887, p. 33 (East Costa Rica; Gaige, Hartweg and Stuart, Occ. Papers Mus. Zool. Michigan, no. 357, 1937, p. 10 Río Mico, 10 mi. above Recero, Nicaragua); Smith and Taylor, U. S. Nat. Mus. Bull. 199, 1950, p. 69 (*Corytophanes*) (Veracruz to Costa Rica).

Corythophanes mexicanus Cope, Proc. Amer. Philos. Soc., 1884, p. 183 (*fide* Cope).

The figure designated *Lacerta ceilonica cristata et pectinata* in Seba's Thesaurus, vol. 1, p. 147, pl. 94, fig. 4, served Merrem as the type of this species. Merrem presumably saw no specimen. It is obvious that the locality, Ceylon, is erroneous. Smith and Taylor have restricted the type locality to Orizaba, Veracruz, Mexico.

Corythophanes percarinatus A. Duméril is reported (with a question) from Ecuador, by Boulenger. The species is certainly known from Guatemala. It should be looked for in southern Central America.

Description of species (From KUMNH No. 34308, Golfito, Costa Rica): Head and body compressed; a fine rather indistinct fold from jaw angle, curving above arm along side to groin; a lateral fold low on the sides from axilla to groin; skull casquelike with sharp canthal ridges continued above and behind eye until they meet and then continue on to the tip of the bony casque; from this high elevation a nuchal crest descends diagonally to the body and is continuous with the low dorsal crest on the body.

Head longer than wide, the snout narrowed and rather blunt; rostral about twice as wide as high, bordered behind by two labials, and a pair of postrostrals, separated mesially by a small scale; nostril in an enlarged nasal, the opening directed nearly backward, situated about equidistant from orbit and tip of snout, separated from the rostral by postrostral and two vertical series of scales, from canthals and labial each by a row of small scales; scales on snout, frontal, and occipital areas irregular, not keeled; semicircular supraocular series differentiated, each consisting of ten or eleven scales, separated mesially by at least two irregular rows of small scales; three or four of the supraocular scales are larger than the others; canthal, supraciliary, and postocular ridges continuous; beginning with the anterior elevated canthal scale above nasal, there are twenty scales

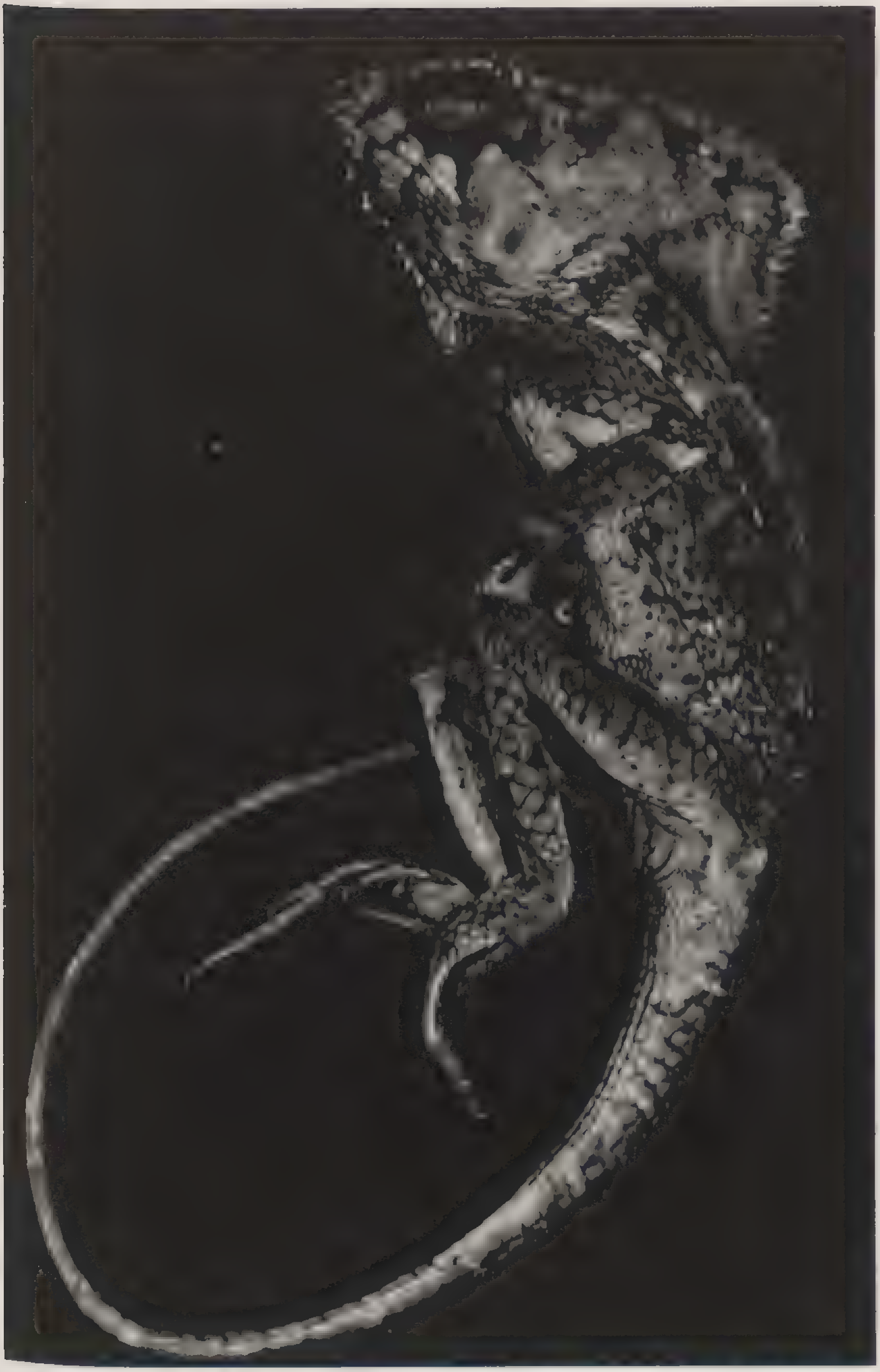

Fig. 45. *Corythophanes cristatus* Merrem. KUMNH No. 36121, Suretka, Limón Province, C. R.; actual length, snout to vent, 104 mm., total length, 325 mm.

on each lateral crest anterior to their junction, beyond which there are eight scales to the summit of casque; area enclosed by the lateral ridges depressed, the supraorbital areas not elevated; about eighteen scales in loreal region in about five rows; supralabials, 12-15, the line of mouth behind eye level, bending down somewhat; infralabials 12, the posterior ones small; all labials somewhat tubercular; the scales below infralabials definitely keeled with from one to three keels; eye-opening diagonal to line of mouth, about size of tympanum; eyelids continuous around eye, covered with very numerous small granules; scales on temporal region and on the sides of the elevated part of casque irregular in size, without keels except three or four enlarged scales that bear tubercles or short keellike ridges; tympanum a vertical oval, twice as high as wide; a distinct nuchal fold in front of shoulders; scales on chin forming parallel longitudinal rows, separated by minute granules; median row forming a low serrate crest; gular pouch present, inconspicuous; scales on side of body somewhat irregular, unkeeled except for more or less distinct vertical series of larger scales that bear a low keel terminating in a slightly elevated tubercle or spine; scales below second lateral fold are larger, forming transverse rows, strongly keeled, mucronate.

Scales on limbs enlarged and keeled; preanal scales only slightly differentiated; caudal scales larger than ventrals, monocarinate; basal part with vertical series of larger scales marking whorls; no caudal crest. Limbs moderate, the arm extended forward, the wrist reaches the nostril; the leg extended, the longest toe reaches tip of snout; digits clawed, the base of claw surrounded by two enlarged scales; lamellae under digits with single mucronate keels; scales on palm and sole each with a pearly tubercle or mucrone; no femoral or preanal pores.

Color in life: Top of head greenish as are most of the scales on ridges and crests; on sides of crests a few yellow-green or brick-red scales; body generally blackish, with single scales or groups of yellow scales low on sides continuous with yellow spots on sides of venter; these spots with darker brown edges. Arms and legs greenish or yellow-green with a yellow-cream spot under upper arm, and a very distinct white spot or spots at elbow; a series of dark lines more or less radiating from eye, crossing line of mouth, separated by broader interspaces that are greenish above and brown below, except the last one which is all green. Tympanum surrounded by greenish scales; clay-white irregular spots under thighs; chin brownish black, the median serrate series tipped with yellow; tail brown with eleven magenta-red blotches not forming bands; a brick-red spot in the postfemoral region extending on to tail; some very indefinite darker banding on sides barely suggested; a black x-mark on head between eyes.

Measurements of Corythophanes cristatus

	34308	34306	36121	34305	34307	34309
Total length	358	367	325	345	261	167
Snout to vent	118	107	104	104	84	56
Tail	240	260	221	239	177	111
Length of head to behind jaw	32	..	33	31	23	16
Length to end of casque	56	55	55	53	34	30
Width of head—greatest	20	..	19.8	22	16	13
Height of casque from throat level	44	..	43	41	29	23
Arm	51	53	50	48	41	31
Leg	109	110	100	98	78	56
Fourth finger	15	17	13.5	13	12	9
Fourth toe	25	25	24	22	20	15

Variation: A female from Turrialba (Caribbean drainage, elevation 1900 feet), shows some squamational differences from the specimen described. The rostral scale length is one and one-half times its height, (not twice); the mental has a wider labial border than rostral (smaller); bordered by two scales (by three); serrated scale series on chin smaller, less conspicuous; radiating lines from eye wanting, or not now discernible; and the reddish spots on tail are dim, scarcely discernible.

A specimen taken at Suretka, near the Panamá border differed most from the described specimen. The top of the head is lined and flecked with black, and the area about the eye is black with the radiating lines forming angles at lips, and not meeting on the chin and throat. A series of three cream spots are present on the curving lateral fold above the arm. There are few or no enlarged scales below the lateral fold in the anterior half of body, but numerous on the posterior part, and bluish in color. Many of the scales on limbs and on the base of tail are dark edged. The entire side and crests have very numerous black dots or flecks. The yellowish spots on the venter are obsolete. The markings on the limbs are typical. The spines at the junction of the nuchal with dorsal body crest are very small and likewise small on latter fourth of body. The light dorsal marks on tail are not evident. Light cream areas below the eye between the black radiating lines are strongly defined.

A young specimen (KUMNH No. 34309, 55 mm. snout to vent) has the following markings: very light olive-green becoming very light brown on body; dim radiating darker lines from the eyes meeting on the throat or chin. A lighter area followed by a darker area on the sides of the casque above the arm. The sides have a series of five wide bands, the first and third with a black spot. Large reddish-cream areas about the base of the tail extending slightly onto the back of the femur. The tail is faintly banded, the anterior edge of each band being darker, the band becoming a little lighter posteriorly. The dorsal reddish blotches are indistinct or absent; the venter is more or less banded. Typical light spots are present on arms and legs.

Remarks: The described specimen is a female taken September 9, 1952. When first observed she was depositing her eggs in a cavity dug in the hard soil of a forest path. Five eggs had been deposited and a sixth was laid after capture. When laying her eggs she was seemingly quite oblivious to my presence and was picked up without resistance and made no attempt to escape. A second female was discovered by my friend John de Gooijen of San José, Costa Rica, depositing eggs in a similar cavity dug in the hard earth in a forest path. Six eggs had been laid. This specimen, captured alive, was killed and partially destroyed by a forest rat that gained admittance to the laboratory through the ceiling.

On Aug. 13, 1951, I captured a specimen (KUMNH No. 34305) at the I. A. I. A. Farm at Turrialba, Cartago Province. I was hunting salamanders in a rotten log on the ground and this lizard descended the truck of a nearby tree and came to rest, head down, at a point eight feet from the ground where it remained motionless, watching my movements. After a time I arose quietly, approached the tree slowly, then reached up and apprehended the lizard. It made little or no struggle when captured.

The color changes began immediately and were rather rapid, going from green and olive to brown and blackish. The ventral and caudal markings and the spots on the arms and thighs are evident in the preserved specimen.

The specimens at hand are distributed as follows: Limón Province: KUMNH No. 36121, Suretka. Cartago Province: 34305-34306, 34309, Turrialba. San José Province: 34307 San Isidro del General. Puntarenas Province: 34308, Golfito.

Cope (1875) reports a specimen from Sipurio, Limón Province and I have examined a specimen in the Museo Nacional de Costa Rica from Jiménez, Puntarenas Province.

My specimen, taken at Suretka, had an egg case of a spider plastered to the posterior part of the dorsal concavity in the head, leaving the head with the appearance of being flat in that region.

Genus BASILISCUS Laurenti

Basiliscus Laurenti, Specimen medicum, exhibens synopsin reptilium . . . Viennae 1768, p. 50 (type of genus *Basiliscus americanus* Linnaeus, by monotypy); Stejneger, Copeia, 1936, No. 1, Nov. 15, 1936, p. 136.

Diagnosis: Large arboreal lizards with strong sexual dimorphism; tympanum distinct; no femoral pores; body compressed, covered with small juxtaposed and imbricating scales; males with a head-crest or "helmet", and usually with a dorsal and caudal crest supported by bony rays or spines, the crest however may be reduced to a serrate ridge; gular pouch small or wanting; one or two transverse gular folds; tail long, compressed; compressed toes bordered by a scaled dermal expansion or fringe; lateral teeth tricuspid; pterygoid teeth present; no abdominal ribs.

Four species of this genus are known to occur within the confines of Costa Rica. The name *americanus* used by certain authors for this species was a revival of a pre-Linnaean name given by Seba (Thesaurus, vol. 1, pl. c. fig. 1, "*Draco arboreus volans Americanus sivi Basiliscus*". It would appear that the figure in Seba served as the type of the Linnaean *Lacerta basiliscus.* The specimen itself was later presented to the Paris Museum and served as the type for *Basiliscus mitratus* Daudin (Rept., vol. 3, 1803, p. 310, pl. 42).

KEY TO THE SPECIES OF BASILISCUS IN COSTA RICA

1. Ventral scales keeled, less distinctly so in males than in females; a single triangular head crest, as high as long; dorsal crest of male low (less than 10 mm.); usually a cream or reddish line from behind eye to a point on shoulder, or may continue to rump . . *Basiliscus vittatus*
   Ventral scales smooth 2
2. Crest on head consisting of two parts, the anterior smaller; a high dorsal crest, and a rather high crest on tail, the upper edges of which are scalloped; one or two rows of lateral yellowish or golden spots may be present on sides; eye red . . . . *Basiliscus plumifrons*
   Head crest not divided into two parts 3
3. A high dorsal crest and a high caudal crest, the upper edges serrate but not scalloped, the crests covered with thin, somewhat enlarged scales . . . . *Basiliscus basiliscus*
   No high dorsal crest but a serrate series of compressed trihedral tubercles, touching or separated by smaller scales; a low, serrate ridge on tail . . . . *Basiliscus galeritus*

Basiliscus plumifrons Cope

(Fig. 46)

Basiliscus plumifrons Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1876 (1875) pp. 125-127, pl. 25, fig. 1 (type locality, Sipurio, Costa Rica); Boulenger, Catalogue of the lizards in the British Museum, 2nd Ed. vol. 2, 1885, pp. 108-109; Günther, Biologia Centrali-Americana: Reptilia and

Batrachia, Oct. 1885, p. 55 (no specimens); Ahl, Aquar. Berlin, 1930, pp. 133-136 (photo); Wettstein, Sitzungsb. Akad. Wiss. Wien, Math-naturw. Kl. Abt. 1, and Bd. 143, Heft 1-2, 1934, p. 22 (Finca Hamburg, Río Reventazón; and Finca Waldeck); Gaige, Hartweg, Stuart, Occ. papers Mus. Zool., Univ. Michigan, no. 357, Oct. 26, 1937, p. 10 (Río Siquia, 7 mi. above Rama; and Río Escondido, near Rama, Nicaragua).

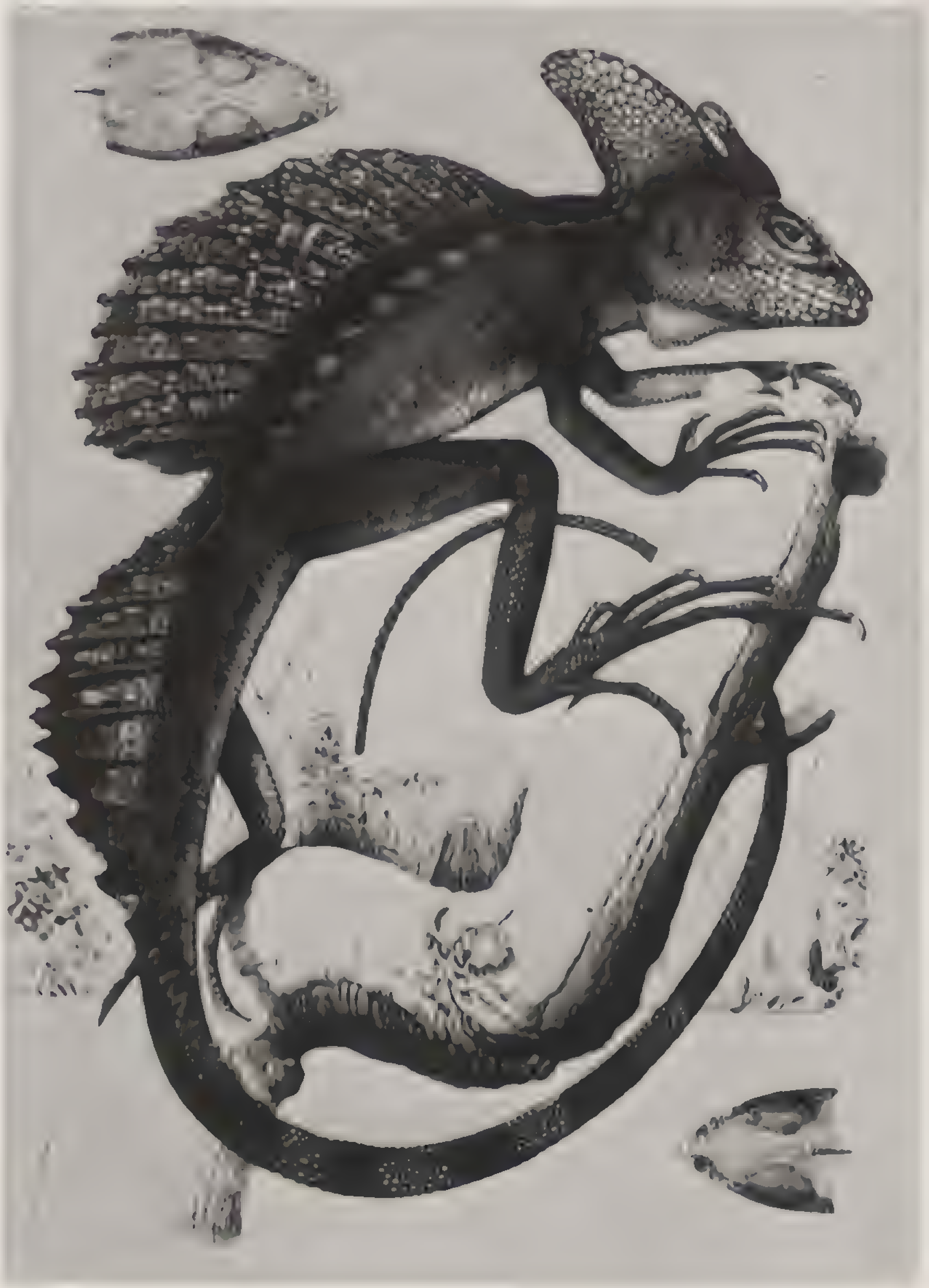

FIG. 46. *Basiliscus plumifrons* Cope. Figure (1 and 1a ♂) (from Cope, Journal of the Academy of Natural Sciences, Philadelphia, ser. 2, vol. 8, 1876 [1875], pl. 25). Presumably type, presumably from Sipurio, Limón Province, Costa Rica (figure 2, upper left is *B. mitratus*); actual length, 655 mm.

Diagnosis: A large arboreal lizard; eye red; head with a small crest arising from between posterior part of eyes, and more or less continuous at its base with a high crest which arises over occiput and terminates about middle of neck; a dorsal and caudal crest; two nuchal folds; the dorsal crest begins at level of arm insertion and continues to above level of femora, supported by 17 bony spines, first low, the highest equal to depth of body; caudal crest continuous but partly separated from dorsal by a deep notch, the upper edge of caudal crest scalloped.

Description of species (From R. C. Taylor Collection No. 491, Turrialba, Cartago Prov.): Rostral large, nearly twice as wide as high, its labial border a little greater than that of mental, bordered behind by a single pair of enlarged postrostrals and the first labials; nostril in a single nasal, the latter separated from rostral by two scales, from first labial by only one scale, from its fellow by eight scales; supraorbital semicircles differentiated, not extending behind orbit; separated by from two to three rows of scales mesially; supraoculars small, in twelve or thirteen rows; scales in median supraorbital area a little larger than those surrounding it; most of the dorsal head scales with single keels or the larger with several fine ridges or keels; "occipital" scale small, immediately preceding the anterior cranial crest; three canthal scales; about twelve supraciliaries, the anterior horizontal but not sharp-edged; frontal scales similar to those on snout; loreal region vertical, the scales in about four rows; pre- and subocular series enlarged somewhat, the suboculars the largest, separated from suborbital labials by a row of small scales, and larger than these labials; supralabials eight-nine, the seventh below middle of eye; eight infralabials, the mouth angle above and below with small granules. Mental bordered behind by a pair of chinshields; three anterior pairs of chinshields in contact with infralabials; scales under chin small, slightly larger on the small gular sac.

Anterior head crest begins at back level of eyes, its base reaching back to anterior level of tympanum; at this point the larger cranial crest begins, rising diagonally rather than vertically the upper part extending farther back than its base which terminates in a small distinct transverse fold about middle of neck; upper parts of crests covered with larger scales than the top of head; dorsal crest begins a little behind the cranial crest, rises gradually to a height more or less equal to the height of body and supported by bony spines 18 or 19 in number; the upper edge of crest somewhat scalloped;

caudal crest more or less continuous with dorsal but a deep notch between, near posterior level of femur; caudal crest confined to basal third of tail only, its upper edge scalloped, supported by eighteen or nineteen bony spines directed up and backwards; tail strongly compressed; crests of back and tail with thin scales, not, or only slightly, imbricate, pointing up and somewhat backwards; occiput with a fleshy elevation; below mouth angle a fleshy swelling; tympanum smaller than eye-opening, strongly diagonal, the upper part forward.

Scales on temporal area, sides of neck and body variable in size but all small, definitely smaller than ventral scales; scales on outer part of arm, and scales on front of femur, above tibia and on foot larger than those on posterior parts of femur, and all keeled; scales on tail (not on crests) keeled; no femoral pores; preanal and postanal scales smooth; digits compressed, the toes on their outer edges with a narrow scaled fringe present on both sides of outer toe; about 40 subdigital lamellae under longest toe, variable in character, some ridged or with ventral knobs. The hind limb laid forward, the longest toe reaches to tip of snout.

Color: Above generally greenish, becoming bluish on the crests; eye bright red; a row of golden spots beginning on the head continue to groin along the sides somewhat below the base of the dorsal crest. A second similar row more or less distinct low on sides; tail with lighter and darker bands, not indicated on distal third. Venter somewhat lighter.

Measurements in mm.: Total length, 714; snout to vent, 194; tail, 520; snout to arm insertion, 85; axilla to groin, 75; length of head, 58; width of head, 32; arm, 90; leg, 181; longest toe, 52; anterior head crest from anterior base to distal point, 33; occipital crest from beginning to most distant point, 50; height of dorsal crest, 40; of longest spine, 45; height of caudal crest, greatest, 37.

Remarks: This species is not uncommon about Turrialba and most of the specimens were obtained through the courtesy of Mr. Curtis Good in the immediate environs of his home at Finca La Dominica, located in the eastern edge of Turrialba. The lizards there have become almost domesticated so that often one could approach to within a few feet of specimens in shrubs or on fences. The yellow or golden spots vary somewhat in their distinctness. Females lack the dorsal and caudal crests but they may have some distinct dark markings across the back, and a tiny head crest with even the small anterior segment in evidence.

Basiliscus vittatus Wiegmann

(Figs. 47, 48)

Basiliscus vittatus Wiegmann, Isis von Oken, vol. 21, p. 373 (type locality, Mexico, restricted by Smith and Taylor to Veracruz, Veracruz, Mexico); Herpetologia Mexicana, 1834, p. 40, pl. 15; Bocourt, Mission Scientifique au Mexique et dans l'Amérique Centrale; Études sur les reptiles, livr. 3, 1874, pp. 129-131, pl. 17, fig. 3 (skull; see this work for early synonymy and literature); Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1876 (1875), p. 125 (Nicaragua and Costa Rica); Boulenger, Catalogue of the lizards in the British Museum 2nd Ed. vol. 3, 1885, pp. 109-110 (synonymy); Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Oct. 1885, pp. 55, pl. 28 (Mexico to Ecuador); Ahl, Aquar. Berlin, 1930, pp. 133-136 (photo); Fink, Aquar. Berlin, 1931, pp. 97-100; figs.; Mertens, Abh. Senck. Natur. Gesel., no. 487, 1952, pp. 45-46, pl. 6, figs. 21-22; pl. 12, fig. 72 (El Salvador localities).

Cristasaura mitrella Gray, Ann. Mag. Nat. Hist., ser. 2, vol. 10, 1852, p. 439 (type locality, Honduras).

Draconura bivitatta Hallowell, Proc. Acad. Nat. Sci. Philadelphia, 1860, p. 482 (type locality, Nicaragua, restricted by Smith and Taylor to Greytown, Nicaragua).

Basiliscus (*Cristasaura*) *nuchalis* Cope, Proc. Acad. Nat. Sci. Philadelphia, 1862, p. 181 (type locality, Greytown, Nicaragua).

Diagnosis: A smaller member of the genus. Scales on venter strongly keeled; nasal touching one, often two, supralabials. Head crest on males subtriangular rising from a point between anterior borders of tympanum. Dorsal crest very low, supported by short bony spines; caudal crest a serrated ridge; a longer or shorter lateral longitudinal reddish or yellowish band usually present; black marks on back usually visible.

Description of species (From KUMNH No. 10152): Body strongly compressed; head rather narrow; rostral large, bordered behind by first supralabials, a scale preceding each nasal, and a pair of postrostrals which meet mesially; an elongate supranasal separated from its fellow by five scales; two canthals continuous with the supraciliaries of which there are seven; supraocular "semicircles" but little curved, consisting of seven-eight larger scales, separated mesially by three rows of smaller scales; scales on snout and frontal area variable in size, rugose but not keeled; supraocular scales in about eight rows, the inner ones larger than outer, bearing an irregular keellike ridge; "occipital" scale slightly enlarged, bearing "eyespot," lying at the beginning of the cranial crest; nasal large, touching one or two supralabials; nostril vertically oval, directed outward; two postnasals; loreal region vertical, covered with four or five scale-rows, the upper the largest; two or three preoculars and one or two suboculars, at least one touching the supralabials; eleven differentiated supralabials to mouth angle, the sixth below the eye; about nine infralabials the sixth below middle of eye; mental with a

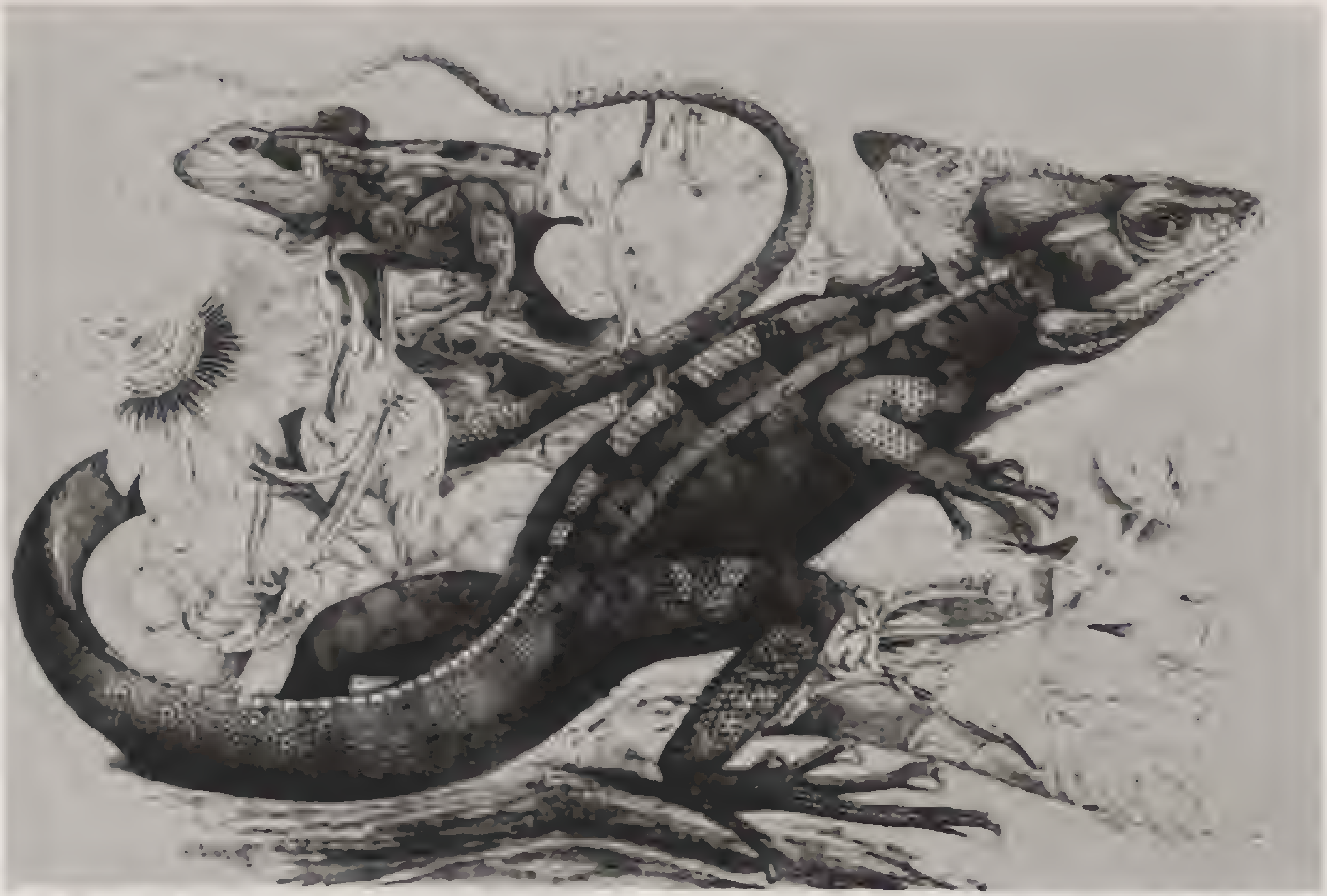

FIG. 47. *Basiliscus vittatus* Wiegmann. Figure from Günther, Biologia Centrali-Americana, Reptilia and Batrachia, pl. 28, male (foreground), female (background).

labial border at least as great as the rostral, bordered behind by two short series of chinshields, only the first pair in contact and these likewise touching first infralabial; scales between chinshield rows subequal forming slightly diagonal rows the free edges of the scales directed mesially; a fold in front of breast, and a slight fold indicated in front of this; gular pouch very small or wanting; auricular opening probably as large as eye-opening, oval, diagonal; scales in the temporal region in twelve to thirteen rows with an indication of a dim ridge running back from eye.

A bony or cartilaginous ridge arises from occiput forming a "helmet" and is continued as a crest terminating at middle of neck; immediately behind this point a dorsal body crest begins, at first represented by á single row of serrate scales then becoming elevated and supported by bony spines; its greatest elevation scarcely greater than greatest diameter of the tympanum; the dorsal crest more or less continuous with the caudal crest, that extends two thirds of the length of the tail, somewhat lower than the dorsal crest, but likewise serrate on its upper edge; tail strongly compressed.

Scales on the sides of the crest larger than other lateral body scales, directed upward and backwards; most of the scales on limbs enlarged, equal to or larger than ventrals, which in turn are larger than lateral scales. Scales on limbs strongly keeled; scales on upper surface of hands, feet and digits with from two to five keels; digits compressed with a fringe of scales on outer edge of digits, usually touching the subdigital lamellae; subdigital lamellae irregular, each scale bearing a dark-colored knob or tubercle except those near the claws; 35-36 lamellae under fourth toes; scales on the ventral surface of the body dimly keeled (strongly in females); subcaudals more strongly keeled. Limbs strong, the leg laid forward, the fourth toe reaches a little beyond tip of snout; the knee and elbow do not touch.

Color in life: Dorsum generally brownish or olive-brownish above, somewhat variegated in shade; tail lighter brown with dim indication of banding on distal portion; below, dull purplish gray with some cream mottling under limbs. Each ventral scale has a little more pigment in center than at edges; a light, slightly reddish brown stripe begins behind eye and continues back along side of neck to shoulder; a second line indicated on side of neck back of tympanum.

Measurements in mm. of KUMNH Nos. 40977 and 40979: Snout to vent 126, 113; tail, 372, broken; total length, 498, 297; snout to

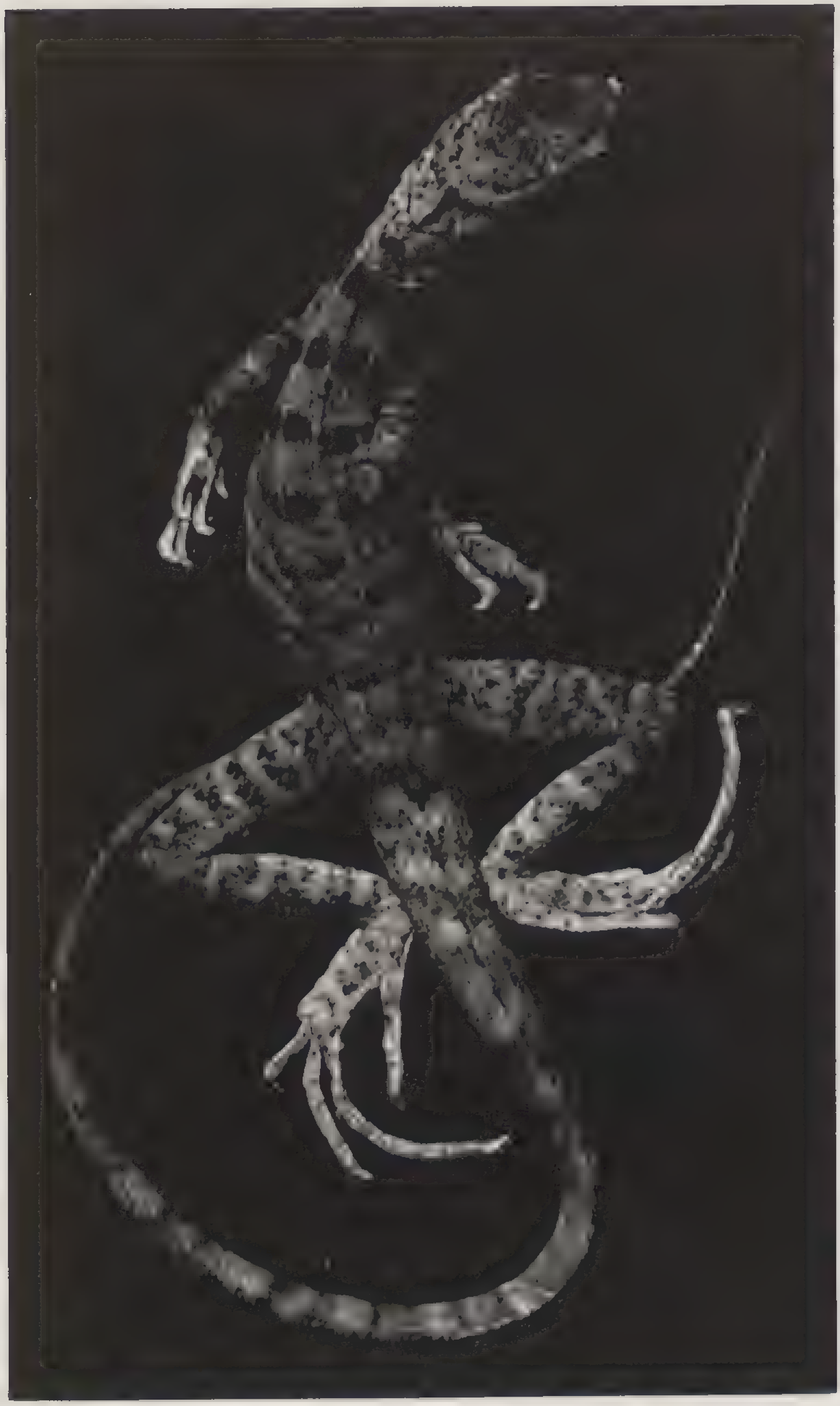

FIG. 48. *Basiliscus bivitatus* Wiegmann. RCT No. 878♀, 5 mi. E. San Isidro; about natural size.

forearm, 53, 48; axilla to groin, 50, 46; length of head, 35, 31; width of head, 21, 19; from anterior base of cranial crest to distal tip, 39; 14; height of dorsal crest, 8, 3; height of caudal crest, 35, 2; arm, 52, 49; leg, 119, 106.

Variation: Sexual variation is especially great since the crests are poorly developed in females. The ventral keels on scales of the females are much better developed than in the male. In one specimen the postrostral scale is broken and the rostral touches a total of seven scales including labials, etc.

The coloration of females differs also. The ground color is olive brown but a series of black quadrangular dorsal spots is present on the sides of the back, sometimes fused mesially or alternating; a light reddish-brown band from eye can be traced to above hind leg, less distinct posteriorly; below this another series of quadrangular dark spots. The lighter intervals between dark spots are mottled in darker and lighter, many of the scales being clay white. Chin and venter dirty cream with numerous black flecks; the legs purplish or lavender below with a mottling of cream. Caudal banding is somewhat evident on basal part of tail (distal part missing). The lips have narrow dark lines between the supralabials which extend down to the infralabials.

Remarks: This species has a wide distribution from Mexico, to Panamá. Cope described the southern form as *nuchalis* believing it to be smaller than the northern form. He later abandoned this idea and synonymized it with *vittatus*. All specimens I have at hand came from the Caribbean drainage areas; and all specimens are from localities less than a thousand feet in elevation.

Basiliscus basiliscus (Linnaeus)

Lacerta basiliscus Linnaeus, Systema Naturae vol. 1, p. 336 (type locality unknown).

Basiliscus americanus Bocourt, Mission Scientifique au Mexique et dans l'Amérique Centrale; Étude sur les reptiles, livr. 3, 1874, pp. 127-129 (Costa Rica. This name is revived from Seba, hence prelinnaean. See this work for older synonymy); Boulenger, Catalogue of the lizards in the British Museum of Natural History, 2nd Ed. vol. 2, p. 108 (Costa Rica).

Basiliscus basiliscus Barbour, Mus. Comp. Zool. Harvard Col., vol. 46, no. 5, 1905, pp. 99-102 (Gorgona Island, Colombia); Parker, Ann. Mag. Nat. Hist., ser. 9, vol. 17, May 1926, p. 550 (Gorgona I. Colombia); Crawford, Ann. Carnegie Mus., vol. 21, no. 1, Nov. 1931, p. 19 (British Guiana); Wettstein, Sitzungsb. Akad. Wiss. Wien, Math-natur. Kl. Abt. 1, Bd. 143, Heft 1 and 2, 1934, p. 22 (Puerto Jiménez and San Isidro de Coronado, 1500 m. Costa Rica); Slevin, Proc. Cal. Acad. Sci., ser. 4, vol. 23, June 25, 1942, p. 466 (Caldera River, Panamá); Evans, Copeia, 1947, no. 3, Sept. 12, p. 168 (Albrook Field, Canal Zone); Snyder, Copeia, 1949, no. 2, June 30, pp. 129-137, pl. 1 (bipedal locomotion).

Description of species (From KUMNH Field no. 10911, 4 km. W. of Tilarán, on road to Los Angeles, Aug. 15, 1954): Rostral large, more than twice as wide as high, angular mesially, having a larger labial border than mental; a pair of postrostrals in contact mesially; a small scale between postrostral and first labial, separating nasal from both postrostral and rostral; nasal with nostril a diagonal oval directed outward; nasal scale irregular, with a ventral portion touching a labial; two canthals; about nine scales between nasals, the outer elongate, keeled, the inner ones irregular rugose or pyramidal; orbital semicircles moderately well defined, separated by three or four series of scales; scales above orbits (supraoculars) much smaller than scales on snout and frontal region, in ten to twelve rows, the inner a little larger than the outer; a strong medial depression just back of eye level; scales of loreal region small, in three or four rows; a row of enlarged preoculars and suboculars, all in contact with labials; 8-9 supralabials, followed by several granular scales; 7-8 infralabials, the back part of mouth bordered by small granules; a pair of large postmentals followed by a series of three large chinshields on each side, the last separated from the infralabials; no distinct gular pouch; two transverse gular folds; scales on chin small, more or less equal; those on throat a little larger; scales in temporal region in about 17 rows, the scales directed forward and upward; tympanum large equal to or perhaps larger than eye-opening; supraciliaries about 14, continuous with canthal scales.

Cranial crest begins from a casquelike structure on occiput, back of the level of a vertical line from tympanum; it joins a transverse fold arising above neck; the posterior upper part of crest narrowed, almost pointed, the scales on the dorsal part of sides more than twice as large as those on the lower parts and on the transverse fold; dorsal crest begins on back between shoulders, nearly an inch behind the transverse dorsal fold on neck; it is supported by about 16 spines directed up and back, longest posteriorly; upper edge of crest serrate; caudal crest separated from dorsal, supported by about 22 spines; scales on caudal crest pointing upwards; upper edge serrate but not scalloped. Scales keeled or ridged on sides of neck and body, all very small, much less than half as large as the ventral scales; scales on upper arm, forearm, and shoulder enlarged, with a median keel, the keels forming lines; ventral scales smooth; scales on front face of femur and above tibia enlarged, keeled. Scales on tail keeled; on crest smooth; subcaudals very heavily keeled.

Limbs large, strong, the toes reaching beyond the snout when the leg is adpressed. Fingers and toes with smooth lamellae on under surface; fourth toe with horizontal series of scales on each side forming a winglike expansion, in contact with the subdigital lamellae; inner toes with a narrow winglike scale expansion on outer edge separated from the subdigital lamellae by one or two rows of scales; lamellae under toes very asymmetrical many having knobs or tubercles; 44 scales under fourth toe, 28 under fourth finger.

Color: Generally green to olive bronze above, with a series of transverse dark bands, one on neck, five on body, the bands dark brown enclosing somewhat lighter greenish areas; tail green, the crest brownish, the uncrested part with dim darker and lighter bands; a lighter line below eye continued under tympanum back to shoulder; venter dirty yellowish white; under limbs mottled greenish purple and cream, some lighter flecking on under surface of base of tail.

Measurements in mm.: Snout to vent, 208; tail, 458; total length, 666; snout to arm insertion, 94; axilla to groin, 85; length of head, 63; width of head, 44; arm, 84; leg, 200; longest toe, 55; height of head crest, 31; length of same from origin to tip, 48; height of dorsal crest, 37; longest spine, 52; height of caudal crest, 30.

Remarks: This form is especially common on the west coast.

Basiliscus galeritus A. Duméril

Basiliscus galeritus A. Duméril *in* Duméril and Duméril, Catalogue Méthodique de la Collection des Reptiles (du Museum d'Histoire Naturelle de Paris), livr. 1, 1851, p. 61 (type locality New Granada=Colombia); Arch. Mus. Hist. Nat., vol. 8, 1856, p. 522, pl. 21; Boulenger, Catalogue of the lizards in the British Museum, 2nd Ed. vol. 2, 1885, pp. 110-111 (Colombia and Ecuador); Parker, Ann. Mag. Nat. Hist., ser. 9, vol. 17, May 1926, pp. 550 (Gorgona I. Colombia).

Ptenosaura Seemanni Gray, Ann. Mag. Nat. Hist., 2nd ser.; vol. 10, 1852, p. 437; *idem.*, 1854, p. 148, pl. xxv.

Basilicus Seemanni Günther, Proc. Zool. Soc. London, 1860, p. 234; Bocourt, Mission Scientifique au Mexique et dans l'Amérique Centrale; Étude sur les reptiles, livr. 3, 1874, pp. 131-133; Cope, Journ. Acad. Nat. Sci., Philadelphia, 2nd ser. vol. 8, 1876 (1875) p. 125.

Basiliscus (*Ptenosaura*) *Seemanni* Cope, Proc. Acad. Nat. Sci., Philadelphia, 1866, p. 123.

Unless it can be shown that the Catalogue Methodique of Duméril and Duméril which bears the date 1851 actually appeared after Gray's paper in Ann. Mag. Nat. Hist., ser. 2, vol. 10, 1852, p. 438, A. Duméril's name, *B. galeritus,* being older than Gray's *seemanni* must be used for this species.

Diagnosis: Body moderately compressed; head crest rounded in profile; the basal part fleshy; dorsal crest reduced to a serrate series of compressed, trihedral tubercles separated by two or more scales; wide toe fringe; ventrals smooth; three anterior chinshields touch the labials.

Description of species (Description composite from type description and from young specimens taken at Golfito, Costa Rica):

Rostral enlarged, bordered behind by first labials, a pair of postrostrals that are in contact, and a scale on each side in front of the nasal; a slender supranasal separated from its fellow by six scales; a postnasal and two or three subnasals separating nasal from labial (or nasal touching labial at a point); nasal larger than surrounding scales, the nostril subcircular directed outward; scales on snout and frontal area somewhat enlarged, ridged or keeled, the keels often transverse; supraorbital semicircles consist of 12 scales, differentiated, keeled, separated mesially by two rows of scales; supraorbital scales in about 12 rows, the median area covered with somewhat larger keeled scales; occipital larger than surrounding scales, bearing "eyespot", separated from the semicircular series by two scales; three canthal scales, continuous with the supraciliary series, which has about eight scales; presuboculars, suboculars, and postsuboculars forming a continuous series, three suboculars in contact with the supralabials; loreal area nearly vertical, the scales in about four rows; nine supralabials, the *seventh* below eye; scales about mouth angle granular; nine infralabials; a mental present, having a labial border equal or slightly less than rostral, followed by two series of chinshields, the first pair in contact behind the mental, the first four in contact with infralabials; scales on chin and throat forming straight longitudinal lines; a fold in front of breast, and a second indistinct fold anterior to this; tympanum broadly oval, smaller than eye-opening; a somewhat enlarged rounded scale a little anterior to lower border of tympanum; temporal scales in about 25 rows from mouth.

Arms and legs with larger, strongly keeled scales on anterior surfaces and on most of the dorsal surfaces; digits strongly compressed with larger scales above, and a well-defined free lateral fringe of enlarged scales on the outer edge of digits (on both sides of the outer toe); subdigital lamellae very irregular and asymmetrical about 40 under fourth toe. Scales on body small anteriorly somewhat tubercular, not strongly imbricating; more posteriorly they may be imbricating and keeled; scales on sides of tail keeled;

scales of venter larger than dorsals, smooth; subcaudals keeled, the two median subcaudal rows enlarged.

In the adult males the head crest rounded in profile arising from a point near the posterior level of the orbits, its basal occipital part thick and fleshy. The dorsal crest consists of a median serrate series of more or less compressed trihedral tubercles, separated from each other by two or more small granules; anteriorly they may be in contact; crest on tail a low serrate ridge.

Color: Bright green or olive on dorsal surfaces, uniform or brown spotted, or sometimes with lateral light spots; tail with dark brown annuli; a white black-edged band from below the eye to the neck; usually another band parallel to the former on each side of the throat.

Young specimens are almost uniform green in life with a strong white line from mouth angle back along neck crossing lower edge of tympanum; throat with a median cream light line and two lateral light lines separated by olive green; belly and under part of limbs and tail base creamy white to flesh white; posterior part of tail grayish below.

Adult measurements given by Boulenger follow:

Measurements in mm.: Total length 670; head 53, width of head 31; body 117; forelimb 78; hind limb 170; tail 500.

Remarks: Three young specimens taken at Golfito, Costa Rica, belong to this species or a closely related form. No adults were seen. Boulenger reports "Five labials to below center of eye" while in the young from Costa Rica the seventh occupies this place. Other differences may be evident on a comparison of adults from Costa Rica with topotypic specimens from Colombia. For the present I am referring these specimens to *galeritus*.

Genus CTENOSAURUS Wiegmann

Ctenosaura Wiegmann, Isis von Oken, 1828, p. 371 (type of genus *Ctenosaura cycluroides* Wiegmann [= *acanthura* Shaw]); Bailey, Proc. U. S. Nat. Mus., vol. 73, art. 12, 1928, pp. 1-58, pls. 1-30 (*part.*).

Diagnosis: Very large lizards. Body not or scarcely compressed; dorsal crest composed of a series of scales extending along all or most of back, more evident in males. Head scales small but larger than very small dorsal scales; a strong transverse gular fold and a gular pouch. Tail with whorls of spinose scales; femoral pores present; lateral teeth tricuspid; pterygoid teeth present; at least one poststernal rib.

As recognized at present only a single species of *Ctenosaurus* occurs in Costa Rica. I have not found the genus occurring in the collections I have made in the Caribbean drainage, but it is not uncommon in those made in northwestern Costa Rica, especially in northern Puntarenas and Guanacaste Provinces.

Ctenosaura similis similis Gray

Iguana similis Gray, *in* Griffith, The Animal Kingdom by the Baron Cuvier, vol. 9; Synopsis, 1831, p. 38 (type locality, [restricted by J. W. Bailey to] Tela, Honduras).

Cyclura (Ctenosaura) similis Wiegmann, Herpetologia Mexicana, 1834, p. 42 (*Patria ignota. Nondum vidi*).

Ctenosaura similis Bailey, Proc. U. S. Nat. Mus., vol. 73, 1928, pp. 32-37, pls. 16-20; Wettstein, Sitzungsb. Akad. Wiss. Wien, Math.-natur. Kl. Abt. 1, Bd. 143, Heft 1-2, 1934, p. 24 (Puerto Jiménez and Bebedero, Costa Rica); Burt, Trans. Micr. Soc., vol. 54, no. 2, Apr. 1935, p. 170 (Puerto Culebra, Costa Rica); Smith, Univ. Kansas Sci. Bull., vol. 22, 1935, pp. 139-140; Journ. Washington Acad. Sci., vol. 39, 1949, pp. 35-36.

Ctenosaura similis [*similis*] Barbour and Shreve, Occ. Papers Boston Soc. Nat. Hist., vol. 8, 1934, p. 197; Smith, Ann. Carnegie Mus., vol. 30, 1944, p. 89; Smith and Taylor, U. S. Nat. Bull. 199, 1950, pp. 73-74.

Ctenosaura cyclura Cope, Proc. Acad. Nat. Sci. Philadelphia, 1871, p. 205 (San José, Costa Rica, Van Patten Coll.); Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1876 (1875), p. 124 (same record as above); Boulenger, Catalogue of the lizards in the British Museum, 2nd Ed., vol. 2, 1885, pp. 195-197 (*part.*) "Colon" [Panamá].

Ctenosaura completa Bocourt, Mission Scientifique au Mexique et dans l'Amérique Centrale; Étude sur les reptiles, livr. 3, 1874, pp. 145-146 (type locality [restricted by Smith and Taylor to] La Union, Salvador).

Diagnosis: A large arboreal lizard variable in color and markings. Body not compressed; crest on body low, composed of a series of separate scales reaching nearly to base of tail; tail with whorls of larger spiny scales separated by two rows of smaller scales on the basal segments.

Description of species (From KUMNH No. 10913): Head flattened on top; the supraorbital areas only slighlty raised; rostral large, triangular, nearly twice as wide as high, its labial border equal to that of mental, bordered behind by first labials and six small scales; nostril large, pierced in a small nasal that is little more than a high rim about orifice; latter directed outward; nasal separated from rostral and labials by three rows of small scales, and from its fellow by eight scales; semicircular series bordering orbit rather poorly defined, separated mesially by at least two scale rows; supraorbital scales small, in about eight rows; occipital scale slightly enlarged; about ten supraciliaries, the anterior ones strongly imbricate, horizontal; scales in loreal region in about five rows, the area vertical; supralabials eleven, bordered above by three rows of small keeled scales forming a small shelf below loreal region; eleven infralabials; the angle of the mouth bordered by fine granular scales above and below; "chinshields" not or scarcely larger than other postmental scales, but very much larger than posterior scales on chin and neck; scales of temporal region smaller than scales on head, forming about fourteen rows; tympanum large, shallowly placed, larger than eye; scales in posttympanic area and above arm minute; scales on dorsum slightly larger; a median crest, arising almost immediately behind occiput and extending to a point between leg insertions; the first four scales of the series increasing in size, 64 in the total series; all body scales keeled; scales on limbs larger than those on body, keeled; ventral scales larger than dorsals, perfectly smooth, as are scales under thighs; basal ten or more segments of tail with transverse whorls of heavily keeled and spinose scales, separated dorsally by two rows of smaller scales; low on sides of tail and ventrally a third whole or part row may be present; posteriorly the annulations can scarcely be differentiated; lateral and ventral caudal scales strongly keeled and mucronate; median caudal scales form a median serrate series; basally the tail is depressed, distally compressed.

Arms and legs well developed, the digits compressed, the third and fourth fingers equal; subdigital lamellae with one or two keels, or spines, 34 under fourth toe; femoral pores, 4-5, each surrounded by six or seven scales. Hind leg reaches ear.

Color in life: Above olive or olive-brown with a short pair of transverse black spots on shoulder separated by green; a second paired transverse spot behind shoulder and another near the middle of back, each pair directed diagonally backward fusing, and forming a black band that runs across belly but is interrupted in the middle; a fourth dorsal black spot can be traced on sides and forms another black ventral band between groins; between ventral black bands the color is dirty olive-green; areas between spots reticulated or speckled black, the black flecks conspicuous on the sides, on breast, and under thighs; darker and lighter bands scarcely indicated on tail; spines in crest black and olive green. The strong transverse gular fold followed by an indefinite black area; head and limbs dark above.

Measurements in mm.: Total length, 652; snout-to-vent, 226; tail, 426; snout to foreleg, 86; axilla to groin, 96; length of head, 61; width of head, 46; arm, 92; leg 148.

Variation: Very much variation obtains, especially in coloration, which may change almost completely in a few minutes. The young are nearly uniform bright yellow-green; some old adults may be almost black or sometimes they may be banded with black and yellow-green.

A female (KUMNH No. 10912) from Bagaces, Guanacaste, Aug. 30, 1954, taken with the preceding described specimen, differs in having five dorsal bands on back separated by gray or clay color. These become indefinite on the middle of the sides then more distinct low on sides but the transverse ventral black bands are lacking. The entire belly is light, flecked with black, the tail strongly banded in black or brown and clay. A longitudinal dorsolateral dark stripe is present on the nuchal region. The lower lip and chin have transverse bands of black and clay, tending to meet under chin, while the throat is mottled with darker. The scales forming the crests are distinct but less than a third the size of those in the male. The squamation on the tail is similar in the two sexes. Femoral pores are indicated by the clustering of six or seven scales about a point. The pores vary between four or five in males; between five and seven in females.

Remarks: The food of this species consists chiefly of the leaves of trees and shrubs, grass, and small terrestrial plants, as well as fruits and small seeds. Some insects especially grasshoppers are also taken. Specimens on the ground usually take refuge in trees when disturbed. Often a large tree, especially if there is a hollow trunk or hollow limbs, offers shelter to a colony of ten or more of these large lizards. From here they may forage a hundred yards or more in varying directions.

In Guanacaste specimens were most prevalent along small rivers and streams where they were a conspicuous part of the fauna.

The species has been reported from Tivives, Bonilla, Orotina, Esparta (near San José), Bebedero, Puerto Jiménez, Puerto Culebra. I have taken it at Bagaces, Tenorio, 4 mi. east of Los Angeles de Tilarán, Puntarenas, and Hotel Marabella.

Genus IGUANA Laurenti

Iguana Laurenti, Specimen medicum exhibens synopsin reptilium . . . 1786, p. 47 (type of genus by tautonymy *Lacerta iguana* Linnaeus = *Iguana tuberculata* Laurenti); Stejneger, Copeia, 1936, no. 3, Nov. 15, p. 136.

Description of genus: Very large lizards reaching a length of approximately five feet; body considerably compressed; a dorsal crest; dorsal head scales large, body scales small; a transverse gular fold; a large nondilatable gular appendage. Digits compressed with keeled lamellae below; a series of femoral pores; tail long, compressed; lateral teeth denticulate; pterygoid teeth present; a sternal fontanelle. One or two poststernal ribs. A very large scale below tympanum in Costa Rican forms. These lizards, widespread from Sinaloa, Mexico to northern South America are present on both sides of Costa Rica.

I have followed Boulenger in regarding *Iguana rhinolopha* a subspecies of *Iguana iguana* since I lack sufficient material to prove otherwise. However the actual relationship between these forms may well be specific since their ranges overlap and the two forms are found together often in widely separated areas.

Iguana iguana rhinolopha Wiegmann

Iguana (*Hypsilophus*) *rhinolophus* Wiegmann, Herpetologia Mexicana, pt. 1, 1834, pp. 44-45 (type locality, by inference, Mexico, restricted by Smith and Taylor to Córdoba, Veracruz, Mexico; Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1876 (1875), p. 124 (low country in southeastern Costa Rica); Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Oct. 1885, p. 56 (Mexico to Darien numerous localities); Bocourt, Mission Scientifique au Mexique et dans l'Amérique Centrale; Études sur les reptiles, livr. 3, 1874, pp. 134-136 (Mexico and Central America).

Iguana tuberculata Parker, Ann. Mag. Nat. Hist., ser. 9, vol. 17, p. 550 (Gorgona I. Colombia); Boulenger, Proc. Zool. Soc. London, 1891, p. 466.

Iguana tuberculata var. rhinolopha Boulenger, Catalogue of the lizards in the British Museum, vol. 2, 1885, pp. 190-191 (no Costa Rican localities).

Iguana iguana rhinolopha Van Denburgh, Proc. Acad. Sci. Philadelphia, 1897, p. 461; Wettstein, Sitzungsb. Akad. Wiss. Wien, Math-Naturw. Abt. 1, Band 143, Heft 1 & 2, 1934, pp. 23-24 (Bebedero and Finca Hamburg, Río Reventazón, Costa Rica); Dunn, Copeia, 1934, no. 1, p. 1; Ahl. Sitz. Ges. Naturf. Freunde Berlin, 1940, p. 247 (El Salvador); Schmidt & Shannon, Fieldiana Zool. vol. 31, 1947, pp. 70, 71 (Mexico); Smith and Taylor, U. S. Nat. Mus. Bull. 199, 1950, p. 72; Dunn and Saxe, Proc. Acad. Nat. Sci. Philadelphia, vol. 102, 1950, p. 153 (range from Mexico to Limón, Costa Rica); Mertens, Abh, Senckenb. Naturf. Ges., No. 487, 1952, pp. 47-48.

Diagnosis: A large lizard (4-5 ft.) with a crest of dorsal scales extending from head onto the tail, the individual crest scales somewhat sickle-shaped (in old adults), curving backward, and rather sharply pointed; a long series of femoral pores reaching length of thigh; a subgular fold with a pointed crest and a large nondilatable throat fan; sides of neck with numerous pyramidal tubercles; subocular scale series continues to above tympanum; a very large scute below tympanum on lower jaw preceded by two large single, or paired scales, superimposed.

Description of species: (Since no adult specimen of *Iguana rhinolopha* is available to me from Costa Rica, I append a description of KUMNH No. 5245F from Tuxtla Gutierrez, Chiapas). Height of rostral about two thirds of its width, nearly vertical, reaching midway between the tubular (elevated) nasals and separated from them by a row of small scales; nostril vertically elongate; on dorsal surface of snout, nasals are separated by three small scales; just back of the level of nasal on median line, two elevated soft spinelike scales, the second highest (9 mm.); two interorbital series of eight enlarged flat scutes, the anterior scales double or triple the size of the posterior, the scales of the series separated mesially by one or two rows of small scales except the anteriormost pair which is separated by two scales, and the pair following is in contact mesially. Occipital small, the "eye-spot" occupying nearly a third of the surface; outer occipital region with a series of three enlarged somewhat pyramidal scales, these separated by about eight smaller scales; supraoculars relatively small in four or five rows, those in the median area a little larger than others; scales of the supraciliary region small. On sides of neck, scales small, in transverse rows, intermixed with about 40 enlarged tubercular scales. Behind nostril a large irregular "postnasal" three times as high as wide; this followed by two superimposed loreals the upper more than double size of lower, much higher than wide; a large somewhat angulate canthal, below which are two superimposed loreals; all larger scales on side of snout separated from the labials by from two to three rows of small scales. Nine quadrangular labials to below middle of eye, followed by three more-elongate scales which may be separated from border of mouth by very small scales. Tympanum large, nearly size of eye; temporal scales in front of tympanum and those of area behind eye not noticeable differentiated except two near upper part, which are tubercular; six enlarged suboculars, the anterior (preocular) much the largest; the scales behind and contiguous with this series are slightly larger than adjoining ones. Mental narrower than rostral, about a fourth wider than high, bordered behind by two infralabials and five scales, the outermost of which are largest and are the beginning of a series of larger "sublabials." Nine or ten infralabials; first two sublabials touch infralabials while those following are separated from them.

Below tympanum, but separated from it by numerous small and larger scales, is a very large subcircular slightly elevated scute, (20 mm. x 20 mm.) its anterior edge on a level with the posterior edge of tympanum; this preceded by a large scute 12 mm. high, and this by one less than half as large. A median longitudinal chin-flap edged with soft spinelike scales; just before the beginning of neck this flap becomes a widened fan having a depth of 70 mm. and covered with small nearly uniform imbricate scales.

Scales covering body minute, subequal, juxtaposed, keeled, arranged in transverse rows to median line of venter, however the scales of venter are larger and become somewhat imbricate mesially. Scales on tail in transverse rows but become more strongly keeled, gradually larger, and subimbricate on the ventral surface. Tail compressed (distal part regenerated). A median dorsal crest begins at head, and extends onto tail, consisting of soft sickle-shaped pointed spines those on neck reaching a height of 44 mm. Those of the base of the tail 25 mm.; however on tail they quickly reduce to an elevation of only two millimeters; about 57 spines from head to back level of thighs.

Scales on anterior and dorsal surface of limbs larger than other body scales, keeled, imbricating, minute on back of thigh; femoral pores, 15-15, extending length of thigh.

Digits of hands armed with strong claws, the subdigital lamellae usually with three keels, a few scales with two keels; twenty-seven lamellae under longest (fourth) finger; lamellae under toes usually bicarinate, 41 under longest toe; on outer side of toes the scalerow adjoining lamellae somewhat serrate.

Color: Usually green in life (especially in young) with or without some evidence of transverse markings and banding on tail; venter lighter sometimes yellowish green; the transverse bands when present usually having sinuous edges; tail banded in green and dark olive (or brown).

The specimen at hand has become nearly uniform black in preservative save that the throat fan is light green.

Measurements in mm.: ♂ Snout to vent, 340; tail (regenerated), 625; snout to ear-opening, 57; snout to arm insertion, 127; axilla to groin, 160; length of head, 75; width of head, 45; height of head, 50; arm, 140; leg, 240.

Remarks: The differences between young and adult animals is very great. While the young, by the presence of the throat fan, show their generic character, there is scarcely a trace of the strong dorsal crest or the spines on the snout to distinguish it from the related subspecific form.

Iguana iguana iguana Linnaeus

Lacerta iguana Linnaeus, Systema Naturae, 10th Ed., 1758, p. 206; Shaw, General Zoology, vol. 3, 1802, p. 199.

Iguana tuberculata Laurenti, Specimen medicum exhibens synopsin reptilium. . . . 1768, p. 49. Boulenger, Catalogue of the Lizards in the British Museum, 2nd Ed., vol. 2, 1885, pp. 189-190 (Nicaragua, Panamá). Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Oct. 1885, p. 56 (Nicaragua, Panamá). Brehm (edited by Franz Werner), Die Lurche und Kriechtiere, Leipzig und Wien, 1913, vol. II, pp. 92-98; Dunn, Copeia, 1934, no. 1, Apr. 24, pp. 1-4, figs. 1 and 2 (distribution).

Diagnosis: Large lizards, one to two meters with a much enlarged scale lying directly below the tympanum, the vertical diameter about equal to vertical diameter of tympanum; large scale preceded by scales all less than one sixth its area.* About seven or eight supra- and infralabials to middle point of eye; nasal scale less elevated; no spinelike scales on snout.

Description of species (From Boulenger (*loc. cit.*), p. 189): "Head moderately large; snout rounded, with obtuse canthus rostralis; nostril rather large, pierced in a swollen nasal, near the tip of the snout; tympanum large, oval; head-scales smooth, variable in shape, large on the forehead and between the orbits; the interorbital series either in contact or separated; subocular scales small; occipital enlarged; rostral large, pentagonal, mental smaller; ten or twelve labials. Anterior border of the gular appendage with a crest of large triangular compressed scales; gular scales very small on the appendage, larger and in several rows on the sides near the labials, increasing in size towards a large circular shield situated below the tympanum. Dorso-nuchal crest continuous, composed of falciform lobes, the length of which varies considerably; most developed in full-grown males. Dorsal scales very small, equal, keeled. Neck with scattered large conical or obtusely keeled tubercles; ventral scales small, larger than dorsals, smooth or indistinctly keeled. Limbs strong, digits long and slender. Twelve to eighteen femoral pores on each side. Tail strongly compressed, crested above, covered with uniform keeled scales which are larger inferiorly. Green or greenish, lighter beneath; upper surfaces uniform, or speckled or variegated with darker and lighter; usually dark, light-edged, undulating vertical bars down the flanks, tail with more or less distinct dark annuli; usually a whitish band in front of arm."

Measurements in mm.: Total length, 1390; tail, 1000; head, 75; width of head, 50; body, 315; arm, 180; leg, 280.

Remarks: There is reason to believe that a careful examination of a large series of these large iguanid lizards may show the presence of forms now unrecognized. Dunn has shown that the presumed subspecific forms may occur together.

My own material is wholly inadequate to settle the problem of the relationship of these creatures.

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* Characters evident in figure. Dunn (1934).

Genus SCELOPORUS Wiegmann

Sceloporus Wiegmann, Isis von Oken, 1828, p. 369 (type of the genus *Sceloporus torquatus* Wiegmann).

Description of genus: Tympanum distinct; body depressed, lacking dorsal and caudal crests; dorsal scales keeled; upper head scales enlarged and differentiated; occipital enlarged; no gular fold or gular pouch; femoral pores present, subdigital lamellae keeled; lateral teeth tricuspid; no pterygoid teeth; no crests on back or tail; no abdominal ribs.

Two species only of this remarkably populous genus are known to occur in Costa Rica, and neither of these seem to pass south beyond the Isthmus of Panamá. The two forms that do occur are subspecies of widespread species, one *Sceloporus variabilis olloporus* Smith ranging from Guatemala to western central Costa Rica, the other *Sceloporus m. malachiticus* Cope, from El Salvador and Honduras south to western Panamá. The first occurs at low elevation along the western slopes and coasts; the second has a wide vertical range from 2500 to 12000 ft. elevation and is found on both the Pacific and Caribbean drainage areas.

Sceloporus variabilis olloporus Smith

(Fig. 49)

Sceloporus variabilis olloporus Smith, Occ. Papers. Mus. Zool. Univ. Michigan, no. 358, 1937, pp. 11-13 (type locality, San Juanillo, Costa Rica); Zool. Ser. Field Mus. Nat. Hist., vol. 26, July 27, 1939, pp. 282-284 (localities for Guatemala, Honduras, Nicaragua, Salvador, Costa Rica).

Sceloporus variabilis Bocourt, Mission Scientifique au Mexique et dans l'Amérique Centrale; Études sur les Reptiles, livr. 3, 1874, pp. 200-202; Müller, Verh. Naturf. Ges. Basel, vol. 6, 1878, pp. 573, 633; Cope, Proc. Amer. Philos. Soc., vol. 22, 1885, pp. 379-397, (*part.*); Boulenger, Catalogue of the lizards in the British Museum, 2nd Ed. vol. 1, 1885, pp. 236-237 (*part.*); Cope, U. S. Nat. Mus. Bull. 32, 1887, p. 36 (*part.*); Günther, Biologia Centrali-Americana; Reptilia and Batrachia, 1890, p. 75 (*part.*); Burt, Trans. Amer. Micr. Soc., vol. 54, 1935, p. 174.

There is a single species of the *variabilis* group known to occur in Costa Rica. It is found only along the western slopes. Specimens are known from as far south as Hotel Maribella, Puntarenas, and may extend even farther south. Seemingly its distribution is limited by increased rainfall in southeastern Costa Rica.

Diagnosis: A form characterized by heavily keeled scales; males with strong lateral light stripes, the keels on the scales forming straight lines that converge on middle of dorsum; femoral pores present, eleven or fewer in number, the two series separated by ten or more body scales; lateral scales more than 47, and less than

59; males with red, blue-bordered areas on sides of belly, this color completely lacking in females; maximum snout-vent measure about 74 mm.

Description of subspecies (From KUMNH No. 34846 Puntarenas, Costa Rica): A medium-sized form belonging to the *variabilis* group of the genus. Rostral subtriangular, twice as broad as high, forming an angle mesially. The labial border much larger than mental border; rostral bordered by a pair of postrostrals, the first labials and a longitudinal scale separating the single nasal from labials; three canthal scales, the canthus moderately sharp; nostril pierced in nasal directed upwards and backwards; nasals separated from its fellow by a pair of supranasals and a pair of scales one of which is broken; two small postnasals; scales of semicircular orbital series consisting of seven or eight scales, large, well defined, in contact mesially, separated anteriorly by a row of scales; five large supraoculars, two or three of which touch the semicircle scales, remainder separated from them by a row of small scales; supraorbitals separated from the supraciliaries by one or two rows of small scales; a much enlarged occipital bordered by the semicircles; all scales on top of head and temporal region rugose or with one to several irregular keels; supraciliaries five or six, strongly imbricate with sharp edges; eyelids well developed, the upper and lower palpebral scales bordered by a row of differentiated scales or lobules; remainder of eyelid covered with small granules; five or six supralabials followed by two or three small granules; five elongate infralabials, both series smooth except for the last, which has a sharp keel; mental subtriangular broader than long, bordered behind by a pair of enlarged postmentals; each of these followed by a series of enlarged scales, all except first separated by one or two scalerows from the labials; scales on chin and throat smooth but notched behind; scales on dorsum, occiput to above vent, 56; all dorsal scales strongly keeled and mucronate, the keels forming nearly straight lines which tend to converge; lateral scales directed backwards and upwards; ventral scales with a single posterior notch, those in groin area with double notches; a small fold in front of shoulder forming a pocket lined with minute granules; a small postfemoral pocket lined with granules; scales on front of thigh, large, keeled; on back of thigh, small but flat and imbricating; part of scales on under side of thigh without notches, perfectly smooth, arranged in five or six rows; behind these a series of 7-10 femoral pores, the series separated mesially

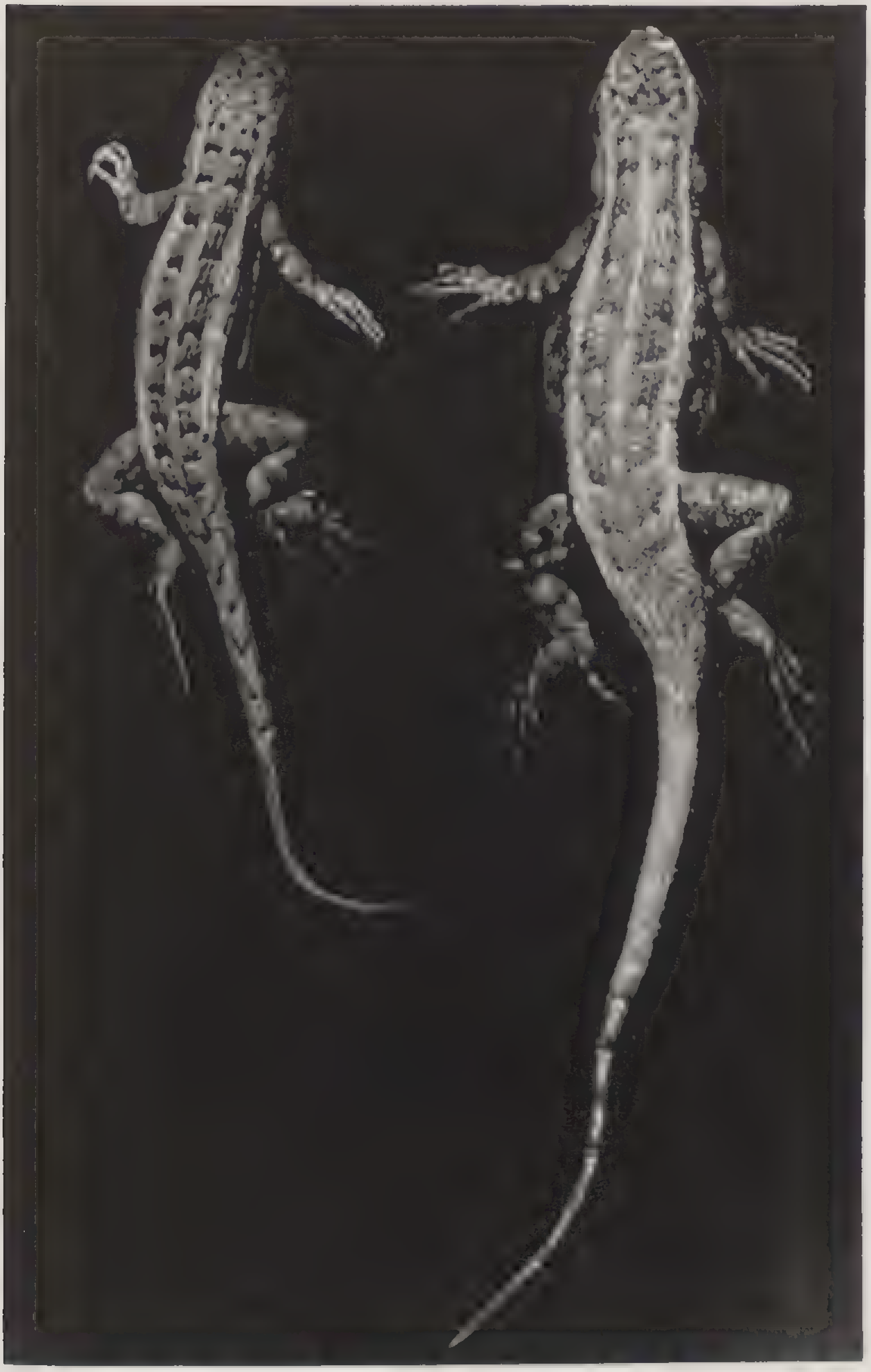

FIG. 49. *Sceloporus variabilis olloporus* Smith. Left figure, KUMNH No. 34842, actual length, snout to vent, 49 mm.; total length, 104 mm.; right figure, No. 34238, actual length snout to vent, 64 mm.; total length, 161 mm.

by about 18 scales; scales in preanal and interfemoral regions smooth; a pair of enlarged well-differentiated postanal scales, separated mesially by two pairs of smaller scales, all set in a depression.

Arms and legs well developed, the hind leg, brought forward, reaching to auricular opening or to some distance beyond; 22-23 multicarinate lamellae under fourth toes, the keels terminating in small mucrones.

Color: Above olive brown to deep brown on back with an indefinite grayish median line; darker areas on each side of median line with indefinite spots; a buff stripe, beginning behind eye, continuing back dorsolaterally on body and slightly onto tail; below this a brownish black stripe extending above hind leg and more or less continued on tail; belly with two reddish or pinkish areas nearly surrounded by dark blue; gular region faintly flecked or mottled (in males); under tail immaculate yellowish white; back of thigh with some rounded buffy spots; tail banded, the terminal bands a little more distinct than the others.

Measurements in mm.: Snout to vent, 59; tail, 97; total length, 156; snout to arm insertion, 20; axilla to groin, 25; length of head, 14.8; width of head, 12.3; arm, 23.3; leg, 39.

Variation: The most conspicuous variation is sexual. In the females the dorsolateral line is dim or obsolete and there is a clearly defined dorsal series of paired blackish spots, about twelve in number, each with a small light, often bluish dot. The color above is light olive-brown or grayish brown. There may be some clouding on chin and breast but the red and blue ventral marks of the male are entirely absent. In some males and especially in young males the dorsal spotting is evident; in old males one cannot, or but barely distinguish the spots. A black spot is usually discernible on the shoulder above arms. The scales bordering the rostral vary; sometimes the postrostrals are separated and the large scales between the supranasals are divided to form two pairs, the anterior of which touches the rostral; this condition obtains most frequently.

The femoral pores in the series at hand vary between seven and nine, the latter number being most frequent. There is a curious difference in the scales of the femoral region in males and females. In males the several rows anterior to the femoral pores are smooth and perhaps glandular and the posterior edge of the scales are rounded; in females these scales are distinctly notched and serrate posteriorly. Males are larger than females, the largest specimen at hand measures 64 mm. (the tail 97, total 161 mm.).

Remarks: The species was very common in the areas close to the sandy beach. Elsewhere they were observed only rarely.

Sceloporus malachiticus malachiticus Cope

(Fig. 50)

Sceloporus malachiticus Cope, Proc. Acad. Nat. Sci. Philadelphia, 1864, p. 178 (type locality, "Upper Costa Rica"); idem, 1871, p. 205 (near San José, C. R.); Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1876 (1875), pp. 95, 127; Sumichrast, La Naturaleza, ser. 1, vol. 6, 1882, p. 38 (*part.*); Cope, Proc. Amer. Philos. Soc., vol. 22, 1885, p. 394 (*part.*); U. S. Nat. Mus. Bull. 32, 1887, p. 36 (*part.*); Ann. Rept. U. S. Nat. Mus., 1898 (1900); p. 335; Schmidt, Field Mus. Nat. Hist., Zool. Ser., vol. 12, 1928, pp. 193; Smith, Proc. Biol. Soc. Washington, vol. 49, 1936, p. 95.

Sceloporus malachiticus malachiticus Smith, Proc. U. S. Nat. Mus., vol. 92, no. 3153, 1942, p. 356 (key); Smith and Taylor, U. S. Nat. Mus. Bull. 199, 1950, p. 107.

Sceloporus formosus Boulenger, Catalogue of the lizards in the British Museum, vol. 2, 1885; pp. 222-223 (Guatemala and Costa Rica); Boettger, Katalog der Batrachier-Sammlung im Museum der Senckenbergischen Naturforschenden Gesellschaft in Frankfurt am Main; Aug. 1892, p. 64 (San José, Costa Rica); Boulenger, Proc. Zool. Soc. London, 1897, pp. 501-503, fig. 3 (*part.*).

Sceloporus irazuensis Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Feb. 1890, pp. 67-68 (*part.*) (type locality, Irazú [Volcán] Costa Rica); Wettstein, Sitzungsb. Akad. Wiss. Wien, math.-natur. Kl. Bd. 143, Abt. 1, Heft 1-2, 1934, p. 25; Smith, Proc. Biol. Soc. Washington, vol. 49, 1936, p. 95.

Sceloporus formosus malachiticus Wettstein, Sitzungsb. Akad. Wiss. Wien, Math.-Natur. Kl. Abt. 1, Bd. 143, Heft 1-2, 1934, pp. 24-25 (San José La Carpintera, Volcán Irazú 2200 m. and 2800 m. San Isidro de Coronado); Smith, Field Mus. Nat. Hist., Zool Ser., vol. 26, 1939, pp. 46-51 (San José, Tablazo, Carpintera, Río Virilla, Tilarán, Santa Clara, Esparta, Irazú, El Copey, La Estrella, between Cartago and Agua Caliente, Barba, Navarro, Río Navarro, Liberia (Guanacaste, 800 ft.), Santa Maria (Guanacaste), Alajuela, Cartago, Puntarenas, San José "Upper Costa Rica," San Isidro de Coronado, Finca Guayabillos 2200 m. on Irazú, Finca Chicua 2800 m. Irazú Volcán, Orosi, (all Costa Rican localities); also, Honduras, Nicaragua, and Panamá.

Diagnosis: A medium-sized species of the genus with a maximum snout-vent measurement of 91 mm.; dorsal scales, interparietal to above vent, 32-38; around body 30 to 45 averaging about 37; frontal usually separated from interparietal; supraoculars in two irregular series, one or more frequently in contact with the median head scales; males with a light line along the center of dorsal scalerows; usually only one canthal or if two the first usually forced above canthal ridge.

Description of species (From KUMNH No. 30850, Finca Montechristo, Volcán Barba, Costa Rica): Rostral a little more than twice as wide as high, pointed mesially; separated from nasal by a single scale; nasal subcircular, forming a narrow rim around nostril, separated from its fellow by two narrow supranasals and two larger internasals; a single large canthal scale with an angular edge; frontal single with a median shallow longitudinal depression, preceded by a pair of prefrontals, and these in turn by three frontonasals, the

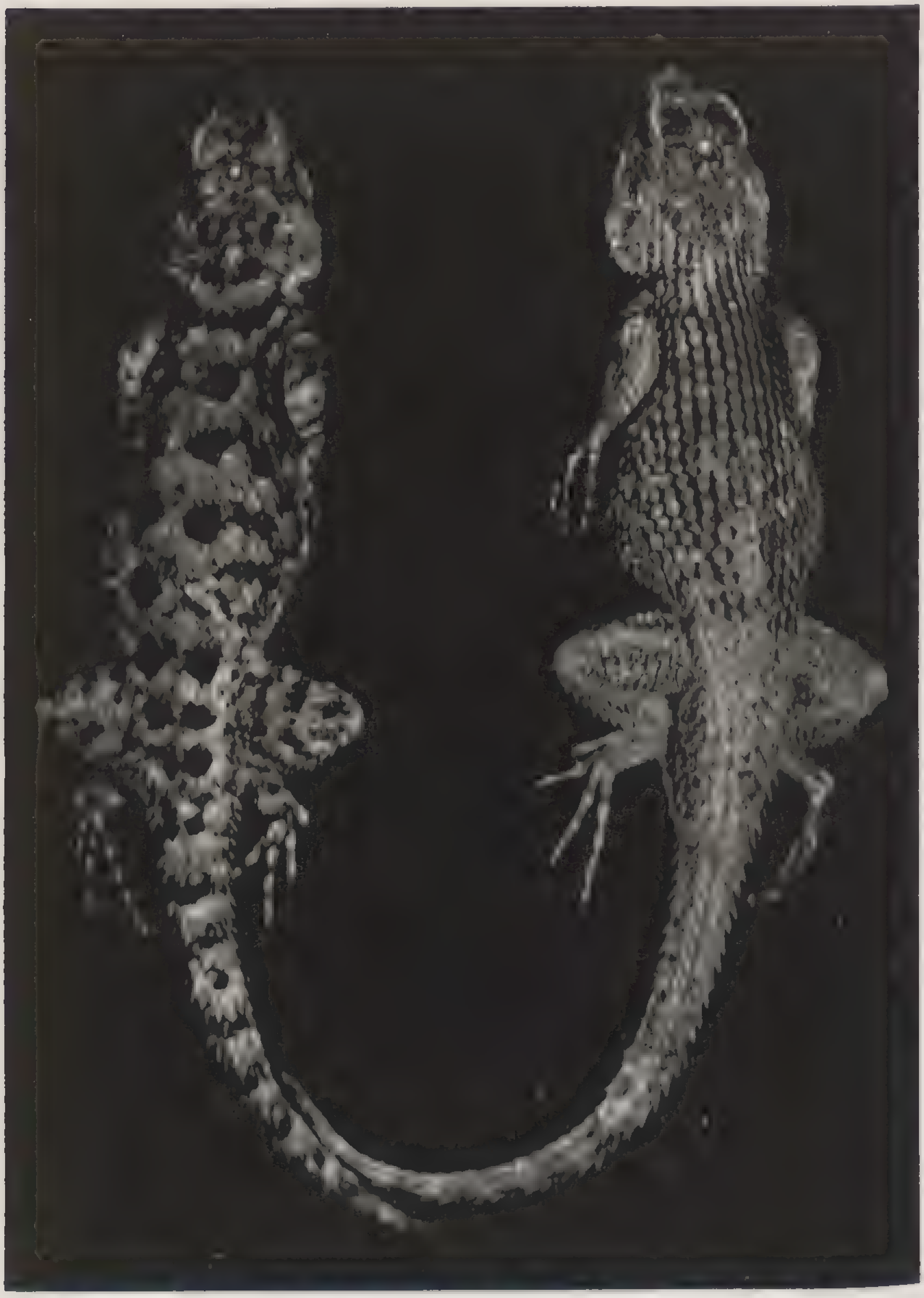

FIG. 50. *Sceloporus malachiticus malachiticus* Cope. Left figure, KUMNH No. 30847 ♀, Finca Montechristo, slope of Volcán Barba; right figure, 30850 ♂, same locality, about natural size.

median separated from the frontal, but touching the interparietal; latter large, somewhat rounded, two pairs of frontoparietals; a pair of parietals much smaller than the interparietal; a row of four enlarged supraoculars, completely separated from median head scales by a complete row of small scales; six supraciliaries the anterior ones strongly imbricated; supraoculars separated from the supraciliaries by one or two rows of scales. First four anterior supralabials smooth, elongate, followed by four elevated keeled scales; an elongate keeled subocular separated from the supralabials by two rows of scales; a single large preocular touching canthal; two loreal scales below and touching canthal; mental small, a little wider than long, followed by a pair of postmentals in contact, the succeeding five postmentals separated; seven infralabials all smooth except last which is keeled; the series except for first, separated from the postmental series by two rows of scales; auricular opening as large or larger than eye with a series of lobulate unkeeled scales along its front edge; on side of neck in front of shoulder a deep depression, overhung by a skin fold, lined with small granules. Dorsal scales large, imbricate, mucronate, the mucrones arising from back edges of scales; lateral scales also with back edge somewhat serrate the mucrones directed upward and backward; ventral scales often with a posterior notch lacking mucrones; femoral pores in a curving series, 15-15; postanals enlarged.

Limbs of moderate length, the dorsal part of arm covered with keeled denticulate and mucronate scales, the mucrones larger on upper arm, the scales smaller than dorsal body scales; scales on under side of arm usually smooth, notched but lacking mucrones. Lamellar formula for fingers: 10, 15, 20, 18, 13; lamellar formula for toes: 9, 15, 20, 21, 15. Caudal scales keeled mucronate, the mucrones more elevated than on body; subcaudals smooth at base but elsewhere keeled and mucronate.

Color in life: Male brilliant yellow-green above on body, limbs, and tail; chin and sides of venter deep blue, the median part covered with a broad longitudinal band of black which reaches neck and is more or less continuous with a deep black spot in front of shoulder; top of head olive.

Preserved specimens lose the yellow-green color but show indefinite bluish lines along each scale row.

Measurements in mm.: Snout to vent, 76; snout to ear, 16; snout to leg insertion, 27; axilla to groin, 50; head length, 20.5; head width, 24; arm, 35; leg, 46.

Variation: The female in life is dark olive with paired black spots, nine or ten in number from head to above base of tail, the spots continuing on tail but usually fusing mesially towards the end. On sides other dark spots often tending to fuse to the dorsal series; ventral areas olive, tending to dull salmon in median ventral region and under tail.

Squamational variation is considerable. The frontal is often transversely divided and the size of the prefrontals varies so that they may be in contact or separated allowing the frontal to touch the median prefrontal; the small outer row of supraoculars may be larger or smaller than in the described specimen.

Remarks: The species occurs from an elevation of about 2000 ft. (at Moravia de Chirripó, Limón Province) to between 11,000 and 12,000 ft. on the highest mountains. No specimens were seen at Turrialba which is but little lower than Moravia. In San José, the capital city, the species is very numerous on the houses and in gardens. One favorite hiding place is the tiled roofs of the buildings.

Most of the specimens in the collection are from the mountains, Volcán Poás, Volcán Barba, Volcán Irazú, Volcán Turrialba, the Meseta Central, and the northern part of the Talamanca Range.

FAMILY ANGUIDAE

Anguidae Cope, Proc. Acad. Nat. Sci. Philadelphia, 1864, pp. 227-228.

When Cope distinguished this family it did not include the gerrhonotine lizards. These were placed in the family Gerrhonotidae containing the genera *Barisia* and *Gerrhonotus.* Boulenger (Ann. Mag. Nat. Hist., ser. 5, vol. 14, 1884) later combined the Gerrhonotidae with the Anguidae.

Three genera are recognized in Costa Rica. They may be distinguished by the following key:

KEY TO COSTA RICAN GENERA OF THE ANGUIDAE

1. Claws retractile into a terminal sheath; two prefrontals and an azygos median prefrontal scale, or the three fused into one scale, *Diploglossus*
   Claws not retractile into a sheath.............................. 2
2. A lateral groove along body from axilla to groin.............*Barisia*
   No lateral groove along side; one large prefrontal...........*Celestus*

Another genus of the Anguid lizards to be looked for in Costa Rica is the recently distinguished genus *Colyptychon* Tihen. This strange Gerrhonotine lizard is represented by one species, *rhombifer.* It is known only from the type locality, Chiriquí, Panama, but may be also an inhabitant of the southern part of the Cordillera Talamanca in Costa Rica.

This form may be distinguished by the presence of two azygos scales following the rostral; ten scalerows across the nape, ten ventral scalerows; a weak lateral fold. Side of neck scaled, with only a trace of a granular patch.

Genus DIPLOGLOSSUS Wiegmann

Diploglossus Wiegmann, Herpetologia Mexicana, 1834, p. 36; Arch. f. Naturges., 1837, p. 130 (type of genus, *Tiliqua fasciata* Gray *).

Description of the genus: Claws completely retractile into a terminal sheath on digits; two prefrontals separated by an azygos median scale (frontonasal), or the three fused into a single scale; scales with fine keels or striations. Caudals lacking heavy keels forming straight ridges.

Two species of the genus are known in Costa Rica. They may be distinguished as follows:

KEY TO COSTA RICAN SPECIES OF DIPLOGLOSSUS

Larger (181 mm.); two prefrontals and a frontonasal (azygos prefrontal); body with about 12 broad dark bands separated by narrow lighter lines. *monotropis*

Smaller (96 mm.); one large prefrontal and no frontonasal; without dorsal dark bands; ocelluslike marks on sides more or less distinct. *bilobatus*

Diploglossus monotropis (Kuhl)

(Fig. 51, 52)

Scincus monotropis Kuhl, Beiträge zur Zoologie und vergleichende Anatomie, 1820, p. 128 (type locality, Jamaica? (*fide* Bocourt,) *ex errore*?)

Diploglossus monotropis Wiegmann, Herpetologia Mexicana, 1834, p. 36; Arch. für Naturg., 1837, p. 130; Peters, Monatsb. Akad. Wiss. Berlin, 1864, p. 48; Cope, Proc. Acad. Nat. Sci. Philadelphia, 1868, p. 98; Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1876 (1875), p. 118 (Costa Rica); Proc. Amer. Philos. Soc., vol. 17, Aug. 14, 1877, p. 92 ("East side Isthmus of Darien"); Bocourt, Mission Scientifique au Mexique et dans l'Amérique Centrale; Études sur les Reptiles, livr. 6, 1879, pp. 391-393, pl. 22, fig. 6a-c (figures of the type specimen, said to be from Jamaica); Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Oct. 1885, p. 34, pl. 23 (Costa Rica; Isthmus of Darien; Ecuador); Boulenger, Catalogue of the lizards in the British Museum (Natural History), 2nd Ed., vol. 2, pp. 285-286 ("Esmereldas"); Cope, U. S. Nat. Mus. Bull. 32, 1887, p. 43 (summit of Pico Blanco); Smith and Taylor, U. S. Nat. Mus. Bull. No. 199, Nov. 20, 1950, p. 214 (probably not in Mexico).

Tiliqua jamaicensis Gray, Ann. Mag. Nat. Hist., vol. 2, 1839, p. 293 (*fide* Boulenger, Günther) (type locality "Jamaica" *ex errore*).

Camilia jamaicensis Gray, Catalogue of the specimens of lizards in the collection of the British Museum, 1845, p. 119.

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* Wiegmann listed two species, *D. monotropis* Kuhl and *D. fasciatus* Gray. Seemingly neither was chosen as the type. Fitzinger, 1843, designated *Tiliqua fasciata* Gray.

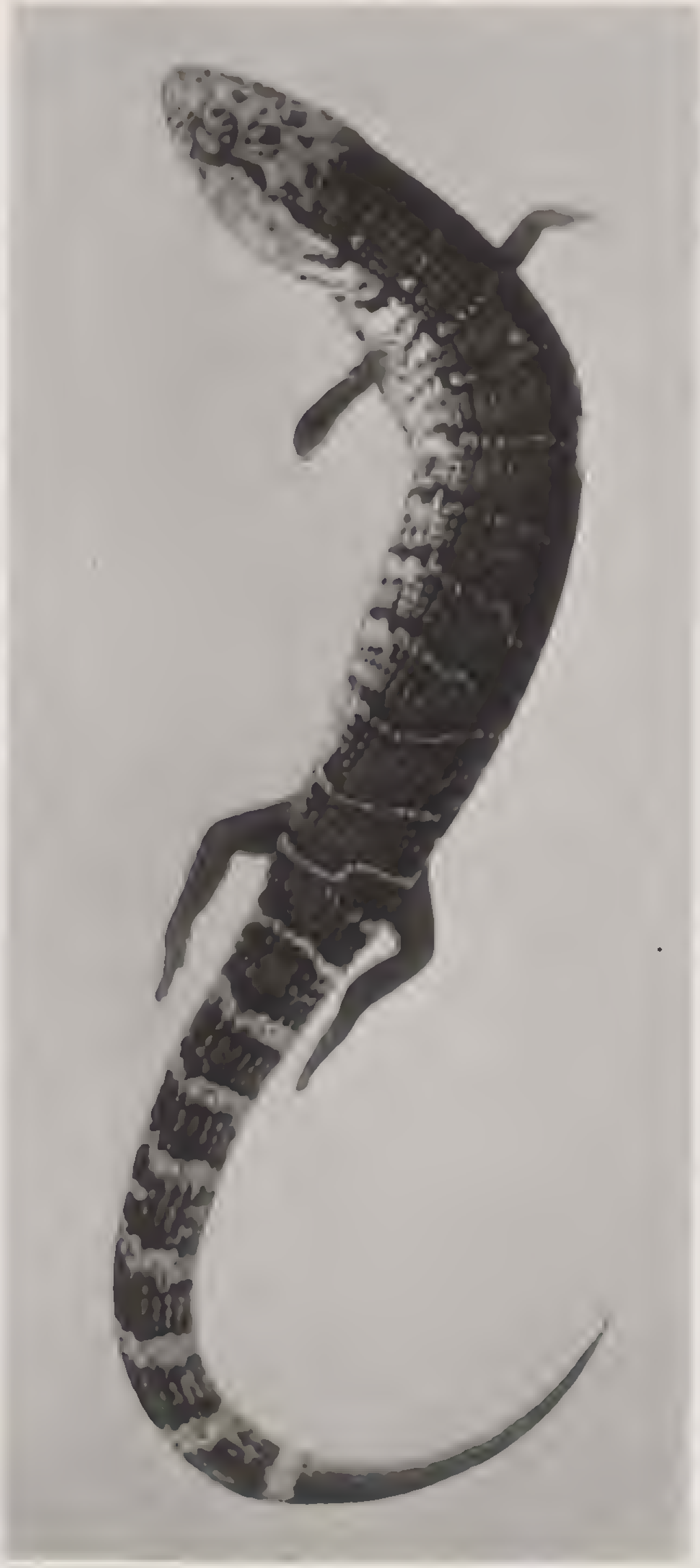

Fig. 51. *Diplogossus monotropis* (Kuhl). KUMNH No. 34290, edge of Lake Bonilla, Tunnel Camp (near Peralta), Cartago Province, C. R.; actual length, 369 mm.

Diagnosis: A large species reaching a snout-vent length of 184 mm.; digits terminating in large single sheath into which the claws are completely retractile; a frontonasal and two prefrontals; body scales with a strong median keel and about thirty other striae; back with twelve broad dark bands; the sides with vertical or slightly diagonal lines of dark blackish-brown and red.

Description of species (From KUMNH No. 34290, edge of Lake Bonilla, Tunnel Camp (near Peralta), Cartago Prov., Costa Rica): A large lizard with a snout-vent length of 184 mm.; the head wider than neck, somewhat depressed; snout broad, short; rounded canthus, the snout tip not strongly truncate; rostral small, wider than high, visible above; two pairs of internasals, the anterior pair smaller but close to rim of nostril; frontonasal large, touching frontal, laterally in contact with upper postnasal, and a prefrontal; latter scales rather narrowed, diagonally placed; frontal longer than wide, longest on median line in contact with three (or two) supraoculars; frontoparietals small, separated from each other by posterior part of frontal and the interparietal, separated from the supraoculars by an intercalated scale; parietals large, separated; postparietal single, enlarged; scales bordering parietals slightly larger than the contiguous body scales.

Nostril pierced in the posterior part of nasal, leaving only a very narrow border separating nostril from adjoining scales; an entrant suture from above to nostril; one small supranasal; two postnasals, the upper a large scale and might be regarded as a loreal or canthal; anterior loreal largest, above touching the prefrontal, below in contact with two labials; second loreal lower, nearly as high as the preocular, both separated from the supraoculars by an elongate supraciliary; five inner supraoculars, the second largest; two outer; five supraciliaries, the anterior elongate, quadrangular; a series of suprapalpebral scales separates the supraciliaries from the palpebrals; lower eyelid with a palpebral series and two series of about twelve scales covering the eyelid, upper largest; two or three pairs of postoculars; six suboculars, separating labials from eye; ten supralabials; the lower anterior temporal wedged between the seventh and eighth labials; four anterior temporals, five secondaries, six in the tertiary series; mental smaller than rostral; a rather large azygos postmental touching two labials laterally; three paired chinshields, first in contact mesially, the second pair separated by a single scale, the third by three scales, a small fourth pair separated by four scales; the two last pairs likewise separated from the labials (touching in one of the third pair); auricular opening moderate, surrounded by about 17 scales, tympanum deeply sunk.

Arms short (hand missing on one side), the scales smooth on front of arm but keeled or striated on upper and posterior sides, the keels appearing as linear series of tiny tubercles under a lens; fingers covered with rows of small smooth scales, each terminating in a large single scale under which the claws are retracted and hidden completely or with only the extreme tip visible; palm covered with somewhat enlarged moundlike scales; the subdigital lamellae single, some seemingly bearing indefinite median keels. Legs relatively short. Scales on front surfaces smooth, those on dorsal and posterior surfaces similar to those in relative position on arm; squamation of toes similar to that on fingers; adpressed

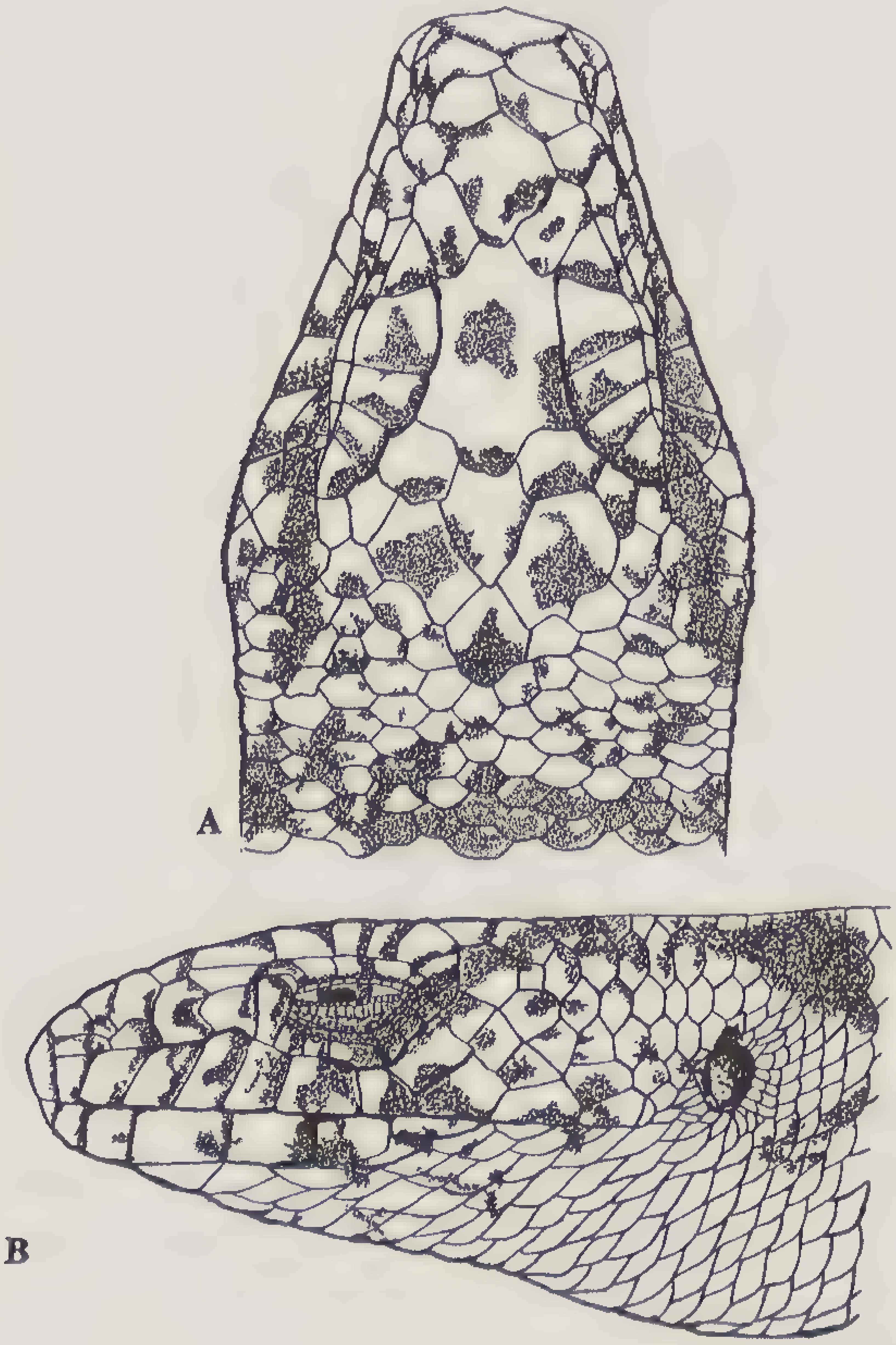

FIG. 52. *Diploglossus monotropis* (Kuhl). KUMNH No. 34290. A. Head, dorsal view; B. Head, lateral view (enlarged, somewhat diagrammatic).

limbs separated by seven transverse scale rows. Tail tapering gradually, laterally compressed, terminal part regenerated.

Scales smooth on dorsum for several rows behind the parietals; scales following these each with a large median keel and from 14 to 16 lateral keels or striations, the scales forming rather irregular transverse rows round the body; scales on dorsal part of tail similar; lateral scales on body and tail with the median keels obsolete and the subsidiary keels less distinct; scales in temporal regions smooth, as are ventral scales on body and tail; scales on regenerated part of tail irregular, smooth; vent bordered by four larger median scales with about four smaller ones on each side; scales about neck 43; around middle of body 37; one inch back of vent, 22 around tail base; 12 ventral rows immaculate.

Color, in preservative: Ivory on chin, throat, venter, and underside of original part of tail; the lateral vertical stripes light cream, similar to venter; the narrow bands across back of body are paper-white while those on tail are dull cream; regenerated part of tail brownish for the most part.

The figure given shows the distribution of the dark and light coloration of the sides. Each dorsal scale has a lighter center and these together form indefinite longitudinal dorsal lighter lines. No trace remains of original red color on the sides.

Measurements in mm.: Snout to vent, 181; total length (tail regenerated), 369; original part of tail, 115; regenerated part, 73; axilla to groin, 90; snout to eye, 13, snout to ear, 34; snout to arm insertion, 60; head width, 28; head length, 42; greatest width of body, 30; width of tail one inch behind vent, 17; height of tail at same point, 20; arm, 36; leg, 47.

Remarks: This specimen was shot by Prof. Marco Tulio Pacheco in vegetation growing at the edge of Lake Bonilla, at Tunnel Camp, near Peralta, Cartago Province, Costa Rica, and presented to the University of Kansas Collection.

It is remarkable that this large, brilliantly colored species has been reported only once previously in Costa Rica. Lake Bonilla is at low elevation (about 1,000 ft.) while the specimen previously known was said to come from the top of Pico Blanco, at an elevation of perhaps 8,000 to 11,000 ft.!

The differences in markings in the specimen described and the specimen figured by Günther (*loc. cit.*) is striking, strongly suggesting that two forms may be involved. I am uncertain whether the specimen figured by Günther is the specimen from Ecuador, mentioned by Boulenger (*loc. cit.*), but presume that such is the case. I suspect the type specimen actually came from Central America.

Smith and Taylor (*loc. cit.*) have concluded that a U. S. National Museum specimen recorded from "Colima" is incorrectly labeled.

Diploglossus bilobatus (O'Shaughnessy)

(Fig. 53)

Celestus bilobatus O'Shaughnessy, Ann. and Mag., Nat. Hist., ser. 1874, vol. 13, p. 257 (type locality, Costa Rica).

Diploglossus (*Celestus*) *bilobatus* Bocourt, Mission Scientifique au Mexique et dans la l'Amérique Centrale; Études sur les Reptiles, livr. 6, 1879, pp. 382-383, pl. 22A, figs. 1, 1a (no specimen).

Diploglossus bilobatus Boulenger, Catalogue of the lizards in the British Museum, vol. 2, 1895, pp. 286-287 (Costa Rica); Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Oct. 1885, p. 34 (Costa Rica, type only).

Diagnosis: A single prefrontal; no frontonasal; six supralabials to below middle of eye; adpressed limbs separated by a distance greater than length of arm; dorsal body scales with ten to twelve fine keels or striations but no enlarged central keel; claws retractile into terminal single-scale sheaths; mental small, less than half the width of rostral; a series of ocelli on sides more or less distinct; maximum known size, 96 mm. snout-to-vent measurement.

Description of species (From KUMNH No. 34297, Moravia de Chirripó, Limón Province, Costa Rica, 1,900 ft. elev.): Rostral nearly twice as wide as high, very narrowly visible above; two pairs of internasals, the posterior pair largest; frontonasal and prefrontals fused into a single prefrontal more than twice as wide as long (3.5 mm. x 1.6 mm.) concave behind, touching superior loreal and anterior supraciliary laterally; frontal much longer than wide (4.8 mm. x 3.1 mm.) frontoparietals small, separated by the frontal; interparietal relatively small, concave anteriorly, little more than half the size of the parietals; latter scales separated by the interparietal; a postparietal; nasals small, the nostril pierced in posterior part, with an entrant suture from upper rim to nostril. Two superimposed postnasals; anterior loreal touching two labials with a superimposed loreal above it; posterior loreal smaller, touching one labial; a preocular and two small presuboculars; five large inner supraoculars, three in contact with the frontal; 3 outer supraoculars; six supraciliaries, the anterior enlarged, the scale preceding may be regarded as a supraciliary or a fourth loreal superimposed above the second loreal; a row of semitransparent quadrangular scales on eyelid bordering lower palpebrals; and these in turn separated from large subocular by two rows of granular scales; five postoculars; four an-

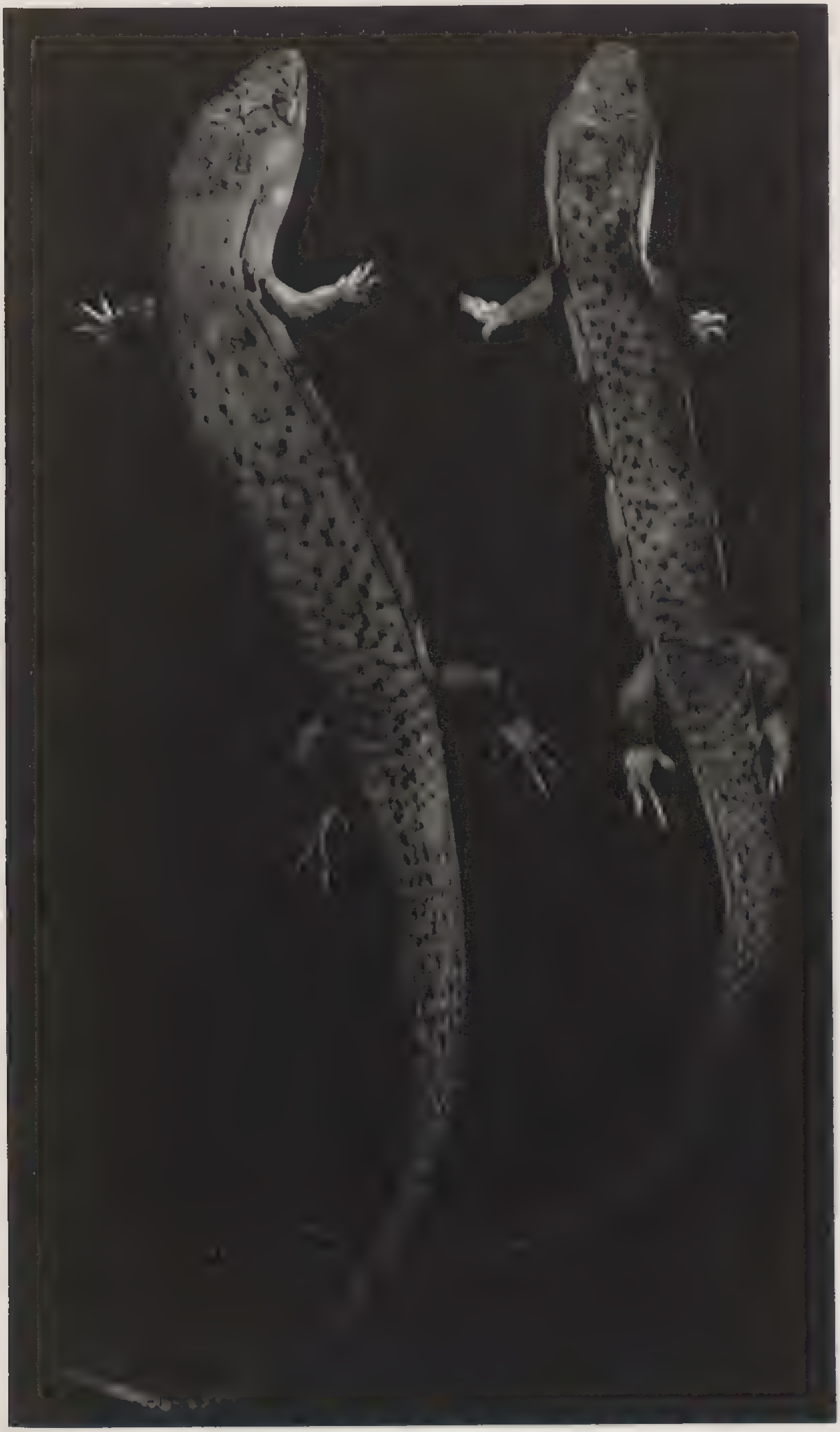

FIG. 53. *Diploglossus bilobatus* O'Shaughnessy. Left figure, KUMNH No. 40988, near summit Mt. Mirador, near Suretka, Limón Province, C. R.; actual length, 200 mm.; right figure, KUMNH No. 40987, same locality; actual length, 197 mm.

terior temporals, second and fourth largest; ten supralabials, six to point below middle of eye; seven or eight infralabials; mental small, less than half width of rostral; a large postmental touching two labials laterally; four pairs of chinshields, first pair bordered by labials and in contact mesially; second pair separated or not from labials, separated from each other by one scale; third pair separated from labials and from each other; fourth pair small, separated, scarcely differentiated.

Dorsal scales of body and tail with more or less distinct keels or striations, except in nuchal region where they are smooth, each scale with ten to twelve keels; lateral scales with some keels, especially posteriorly; scales on limbs smooth; six median preanal scutes.

Arm short, the digits terminating in a large scale into which the claws are completely retractile; behind the base of the claw is a U-shaped scale; ten subdigital lamellae below two longest fingers; leg short, the claws similarly retractile, about fourteen lamellae under longest toe; palm and sole with moundlike scales, not contiguous with each other.

Color in life: Head black; dark bronzy olive on neck and back of head; back mottled or reticulated bronzy green and black; a discontinuous dorsolateral line about the width of a scalerow, greenish yellow anteriorly, growing more green posteriorly; sides greenish, with black and greenish-white ocelli; pinkish under legs and at base of tail; chin whitish; venter greenish bronze; legs black above; some dark and light marks on labials and below eye; dorsal part of digits blackish.

Measurements in mm.: Snout to vent, 85.5; tail, 84 (regen.); snout to ear, 13; snout to arm insertion, 23; axilla to groin, 55; arm, 13.8; leg, 18; head width, 10.8; head length, 16.

Variation: The collection contains the following specimens all from the Caribbean drainage. Limón Province: Nos. 34293-34298, Moravia de Chirripó; 34302, Limón; 34303, La Lola; 34304, Los Diamantes, Guápiles; 40987-40989, Mt. Mirador, Suretka. Heredia Province: Nos. 34299-34301, Cariblanco; 40990-40991, Cinchona. Many of these localities are from relatively low elevations, Limón being only a few feet above sea level, Los Diamantes at about 900, while Moravia de Chirripó is approximately 1,900 feet. On the other hand the Cinchona locality is between four and five thousand feet. However, there is some variation that is pertinent. Scales of young specimens lack striations but there is a suggestion of a median elevation on the scales not evident in older specimens. Specimens

Nos. 34299, Cariblanco, and 34304, Los Diamantes, the northernmost localities, have the keels on the scales most distinct. The keeling covers the dorsal scales to the postparietal, the scales on the sides of neck and body, and even those on the venter. In No. 34299, a younger specimen, the posterior part of venter is keeled and in No. 34304 the keeling extends from breast to vent. This ventral keeling is not evident in younger specimens from Cariblanco but the scales on the sides of all are strongly keeled to venter. The six specimens from Moravia de Chirripó have the dorsal nuchal scales without keels or they are only dimly evident. Keels on the sides are obsolete for the most part in the described specimen, and in the case of No. 34296 the keels are obsolescent over most of the dorsal surface as well as on the sides. In the others they are moderately developed.

I am unable to explain all these differences on the basis of sex and age. The following miscellaneous field notes show some color variations:

No. 34304 (Los Diamantes). Head yellowish tan, some scales partly outlined in black; discontinuous narrow dorsolateral lines greenish yellow; three lighter flecks below eye. On dorsum magenta-bronze and blackish-olive, the darker color forming irregular transverse wavy lines (in places a reticulum) above; sides olive, darker on upper parts, yellowish olive low on sides; a series of five blackish vertical marks or spots on which there are two or three small greenish-yellow ocelli. Belly bronzy greenish-white, yellowish at vent and base of tail; some salmon color under hind legs.

No. 34298 (Moravia de Chirripó). Somewhat bronzy olive above; salmon pink low on sides, on venter, and subcaudal region; chin white or cream white; lateral ocelli obsolete; dorsal reticulation visible when submerged in clear liquid.

No. 34299 (Cariblanco). Above very dark olive green; vertical rows of yellow-green dots or ocelli in vertical black marks on sides, the largest above arm insertion; fine broken dorsolateral line olive tan; under neck yellow; chin yellow green; belly bronze flesh; underside of tail lemon yellow; under side of legs dull salmon. This resembles No. 8389 but the dorsal reticulation is scarcely discernible.

No. 34300 (Cariblanco). Olive green above with darker flecking or reticulation.

No. 34301 (Cariblanco). Young; tail ultramarine below; yellowish flesh below; chin greenish flesh; belly flesh; ocelli obsolete.

A specimen obtained about 15 mi. WSW of San Isidro del General shows certain peculiarities of color and markings. A series of about 25 irregular or somewhat rounded blue-white spots, each covering one or two scales, extends from the nuchal region onto the base of the tail along the dorsolateral region; between the dorsolateral rows one can discern certain other rows of dim spots tending to form across the back numerous transverse rows or lines of lighter color. On the sides there are six vertical series of three blue-white spots surrounded by darker pigment. Above the arm insertion there are two vertical blue-white, black-edged lines, and on the sides of the neck four dark-edged light spots or lines. The labials are blackish with some light dots or vertical lines. There is no striation of the head scales, but the anterior dorsal scales show trace of striation up to the occiput. There are usually seven or nine striae or keels; toward the end of the tail they become obsolete. The lateral scales are striate, the ventrals smooth; there are 38 scales around the middle of the body. There are 10-11 lamellae under the third and fourth fingers and 18 under the fourth toe; subcaudals are in paired median series. There are two postnasals (frenoculars), and two anterior loreals, superimposed, and two posterior loreals (frenoculars). There are three outer supraoculars and the supraciliary series is very irregular in size.

One female specimen was found under a log brooding six eggs. The others were found by moving fallen tree trunks or piles of chips.

Measurements of Diploglossus bilobatus O'Shaughnessy

Number	Snout-vent length	Arm	Leg	Axilla to groin	Snout to arm	Head width	Head length	Scale rows
34296	79	13	18	48	21	9.6	13.2	37
34295	74	13	18	45	22	9.2	14.6	37
34298	67	13	18	40	20	8.8	14	37
34293	66	12.2	16	37	22	8.6	14.5	38
34294	55	11	14	31	18	8.1	11.2	42
34300	63	12	15	39	20	8	12	37
34299	64	13	16.2	35	20.2	8.7	12	35
34304	78	15.5	22	41	24	11.2	16.2	38
34302	51	10	12	29	16	7.6	11.3	39
34301	32	7	8	16	11.2	5	7.9	37
34303	31	7	8	15.2	11	5.1	8	

Genus CELESTUS Gray

Celestus Gray, Ann. Nat. History, vol. 2, 1839, p. 288 (type of the genus, *Celestus striatus* Gray).

Description of the genus: All digits clawed, the claws not retractile into a terminal sheath; prefrontal single or divided into two scales. Caudal scales with or without strong keels.

This genus has on occasion been placed in the synonomy of *Diploglossus*. It seems that the differences between the two are definitely worthy of generic distinction and they are retained here as distinct genera.

One species, *Celestus chrysochlorus* Cope is definitely known in Costa Rica. Cope has reported a second species from southeastern Costa Rica under the name of the Mexican *Celestus steindachneri*. He had a specimen from Boruca, Puntarenas Province having two prefrontals and 36 body scales. There is a possibility that the specimen is anomalous. While Cope does not mention the toes, one presumes that he placed it correctly in *Celestus*. The specimen is now presumably lost.

KEY TO THE COSTA RICAN SPECIES OF CELESTUS

No prominent keels on caudal or dorsal scales; two prefrontals, *Celestus sp?*

Caudal scales heavily keeled, forming straight ridges; a single prefrontal. *C. chrysochlorus*

Celestus sp.

Cope (Proc. Amer. Philos. Soc., vol. 31, 1893, pp. 342-343) reported a specimen of *Celestus steindachnerii* from Boruca, Puntarenas Province, southwestern Costa Rica. The specimen came in a shipment obtained chiefly on the Pacific slope by Mr. George K. Cherrie, an officer in the Museo Nacional of San José. There seems to be no error in locality.

Concerning the specimen, Cope reports as follows: "From Boruca; No. 300; one specimen. This individual has thirty-six longitudinal series of scales, which have nine longitudinal keels on the middle and posterior parts of the body and on the tail, and are without prominent median keel. Anterior scales smooth. Two prefrontals. This specimen presents characters of both the *C. steindachneri* and the *chalybaeus* Cope, and in some respects differs from both. Whether there is one variable species or not, more abundant material is necessary to decide."

It would appear unlikely that *C. steindachneri* (now *Celestus enneagrammus* Cope), known only from Mexico, should occur in southwestern Costa Rica. Cope's specimen could not be found in the National Museum in August 1953 and is believed to be lost. Presuming that the locality data is correct it seems quite probable that a form, which may or may not be new, awaits rediscovery in southwestern Costa Rica.

Celestus cyanochloris Cope

Celestus cyanochloris Cope, Proc. Acad. Nat. Sci. Philadelphia, 1894, pp. 200-201 (type locality, Volcán Irazú, Costa Rica); Dunn, Notulae Naturae, no. 4, May 26, 1939, p. 3.

Diagnosis: A rather small species, maximum known snout-vent measurement 78 mm.; rostral and mental of equal width on labial border or latter the wider; frontonasal and prefrontals fused into a single scale; most dorsal scales with six to eight striations lacking strong median keels *; all caudal scales with a very strong median keel, the keels making continuous ridges running lengthwise to tip; claws not retractile into a sheath; five pairs of chinshields, only first completely bordering labials; first supraocular excluded from frontal; nearly uniform olive above or golden green with several indistinct longitudinal rows of paler spots mingled with brown spots.

Description of species (From KUMNH No. 34291; Isla Bonita, NE slope of Volcán Poás, Heredia Province, Costa Rica): Rostral less than twice as wide as high, distinctly visible above; anterior internasals narrower than posterior, their common suture about as long as that between second pair; frontonasal and prefrontals fused into a single large scute, much wider than long (2.5 mm. x 1.9 mm.), the posterior border somewhat concave; frontal narrow, much longer than wide (3.4 mm. x 2.1 mm.); frontoparietals small, widely separated by frontal; interparietal nearly as large as the parietals, separating them widely, touching the much smaller postparietal; parietal separated from the supraoculars by an intercalated scale.

Nasal single, nostril pierced in posterior part of scale, the surrounding scales separated from it by a narrow rim; a suture from upper edge of nasal to nostril; a pair of small postnasals (fused together on left side); anterior loreal smaller than posterior; a superior loreal, intermediate in size, touches a second internasal, the prefrontal, first supraocular, first supraciliary, as well as the two other loreals; a large preocular and a smaller presubocular; five inner supraoculars, the second and third bordering frontal, the first excluded from contact with frontal; five outer supraoculars; a series of eight or nine scales, higher than wide, border the lower palpebrals and these in turn separated from subocular by one or two rows of small scales; subocular nearly three times as long as high; a row of four postoculars; preceding postoculars a similar series of smaller scales; anterior temporals four; posterior temporals four; twelve (eleven) supralabials, eight (seven) to a point below middle of eye; eleven infralabials; mental a little wider, but of less area, than rostral; an azygos postmental; five pairs of chinshields, first pair in contact with each other and the second and third labials; second and succeeding pairs separated from each other by from one to five scales, and from the labials by one or two rows of scales. Auricular opening small (.5 mm.) not or but slightly longer than high.

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* Cope states: "About a dozen longitudinal keels."

Arms and legs, when adpressed on sides, touch or are very narrowly separated; arm and leg covered with smooth scales; palm with small close-set tubercular scales; two longest fingers each with 16 lamellae, 23 under fourth toe; distal digital joints somewhat compressed; base of claw with a larger upper and a smaller lower scale; claw not (or very incompletely) retractile.

Scales in 33 rows around middle of body; dorsal scales (including parietals in larger specimens) usually with six to eight fine keels without heavy median keel except on tail; dorsolateral scales dimly keeled, lateral and ventral scales smooth; scales beyond base of tail each with a high median keel, "roof shaped," the keels forming conspicuous continuous ridges; fourteen scales at the base of tail but reducing in number toward tip; lateral keels on each side of median keel. Vent bordered by ten scales, the four median largest; 73 transverse scalerows from parietal to above vent.

Color in preservative: Above dark olive, with a scarcely visible pattern on sides formed by many of the scales having lighter centers which tend to form vertical lines on the dorsolateral areas; similar series of darker scales; the ventral surface is somewhat lighter, each scale showing some darker pigment and these forming very dim lines on each scalerow; the median keels on the caudal scales are light and these together form dim lighter streaks. In life the specimen was "reddish brown above, preanals cream; greenish yellow below."

Measurements in mm. of No. 34291, 34292. (Measurements in parenthesis are those given for the type): Snout to vent, 53, 78, (70); tail, 80, 76 *, (81 *); total, 133, 153 *, (151 *); snout to ear, 10.5, 13.6, (—); snout to arm, 19, 26, (—); axilla to groin, 28.5, 43.5, (—); width of head, 7, 11, (—); length of head, 12, 17, (—); arm, 13, 17.2, (16.5); leg, 16, 21, (22).

Variation: A larger specimen than the one described, (KUMNH No. 34292) is from the same locality. This specimen has shed almost all of the epidermis from the scales on body and tail. It differs in having the limbs shorter in proportion to the axilla-to-groin distance (due to age), and adpressed, they are separated by a distance equal to the length of the hand. The scale rows are 33. There are seven supralabial scales to a point below the middle of the eye.

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* Tail incomplete or partly lost.

In life this specimen was nearly uniform light olive, and lighter below. The specimen has the tail partly regenerated and the regenerated scales have the middorsal keels and lateral striate keels. This seemingly is an attempt to grow a scale similar to those on the original tail. In general, regenerated scales of lizards are unlike the original scales.

My specimens agree fairly well with Cope's type description, allowing for color changes due to preservation.

Remarks: To my knowledge, save for those here listed, no specimens have been reported in the literature since the type was described some sixty years ago. A third specimen obtained at Isla Bonita, (R. C. T. field number 630) was presumably lost in shipment to the States.

Genus BARISIA Gray

Barisia Gray, Ann. Mag. Nat. Hist., ser. 1, vol. 1, p. 190 (type of genus *Barisia imbricata* Wiegmann designated by Stejneger); Tihen, Amer. Mid. Nat., vol. 41, no. 3, May 1949, pp. 596-598, figs. 10-12.

Two nominal species of the genus have been described from Costa Rican specimens: *Barisia monticola* (Cope) and *Barisia alfaroi* (Stejneger).

The type descriptions of the nominal species differ, but it would appear that the differences are due to sexual dimorphism and dichromatism. The type of *monticola* is presumably a female; that of *alfaroi* presumably a male, the sex is not given in either case.

In a recent revision of this genus of lizards, Tihen places Stejneger's *Gerrhonotus alfaroi* as a synonym of Cope's *Gerrhonotus monticolus.* He is of the opinion that the differences are due wholly to sexual dimorphism. I follow him in my treatment of the forms.

Barisia monticola Cope

(Fig. 54)

Gerrhonotus fulvus Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1876 (1875), p. 118 (*nec. G. fulvus* Bocourt).

Gerrhonotus monticolus Cope, Proc. Amer. Philos. Soc., vol. 17, Aug. 15, 1877, pp. 97-98 (type locality, summit of Pico Blanco, elevation 11,500 ft. "Eastern Cordillera of Costa Rica." This is on the border between Limón and Puntarenas Provinces, and near the Panamá boundary. Type, U. S. Nat. Mus. No. 30591); U. S. Nat. Mus. Bull. 32, 1887, p. 42; Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Oct. 1885, p. 35; Boulenger, Catalogue of the lizards in the British Museum (Natural History), 2nd Ed., vol. 2, 1885, p. 278.

Barisia monticola Tihen, Univ. Kansas Sci. Bull., vol. 33, pt. 1, Apr. 20, 1949, pp. 225-227 (*part.*); Amer. Mid. Nat., vol. 41, no. 3, May 1949, p. 598; Amer. Mus. Novitates, no. 1687, Nov. 4, 1954, p. 11 (El Volcán de Chiriquí, Panamá; Volcán Irazú near Cartago, Costa Rica).

Gerrhonotus alfaroi Stejneger, Proc. U. S. Nat. Mus., vol. 32, June 15, 1907, pp. 505-506 (type locality, Santa Maria de Dota northeast of Laguna, San José Province, Costa Rica; elevation 2000 m.); Wettstein, Sitzungsb. Akad. Wiss. Wien, math.-naturw. Kl., Abt. 1, Band 143, Heft, 1, 2, 1934, pp. 28-30, figs. 1-9 (Finca Guayabillos 2200 m. Volcán Irazú; Finca Chicuas 2800 m.; Volcán Irazú; Volcán Poás).

It is obvious from Stejneger's description of *alfaroi* that the specimen is a male. It is also probable that the type of Cope's *monticolus* is a female. Presuming them to be the same species there would obviously be a marked difference in the color patterns. Cope points out that only three or four longitudinal rows of scales are keeled. Stejneger, who had Cope's type before him, in describing *alfaroi,* states that the six median rows are strongly keeled in that species, and that there are 46 transverse rows from occiput to level of vent. Of Cope's type specimen, he mentions nearly smooth dorsal scales, only those on the lower back being obscurely keeled! It is possible that the smoothness of the dorsal scales on Cope's type, when Stejneger examined it, was due to loss of the outer epidermis of the scales. However, the keels on some females may be less marked than in the males.

Diagnosis: Two pairs of internasals; five large inner, two or three small outer supraoculars; a frontonasal present; postmental single, normally; usually two postnasals; at least first paired chinshield touching labials. Frontal single, or often transversely divided in Costa Rican specimens.

Description of species (From KUMNH No. 30800 ♂): Snout bluntly pointed, the rostral twice as wide as high, visible from above as a line; two pairs of internasals, the anterior the longer, the posterior the wider; frontonasal much wider than long, touching an upper postnasal and a large loreal laterally; prefrontals laterally touching loreal, forming a suture with each other; frontal seven-sided, widest near posterior end, touching second and third supraoculars; frontoparietals separated by frontal which is broadly in contact with the interparietal; latter scale separating the parietals; three occipital scales, the outer of which might be interpreted as posterior parietals; five inner supraoculars, and two small outer supraoculars; six supraciliaries; nostril pierced in the posterior part of nasal; two superimposed postnasals; a large loreal touching the third labial only; a large preocular touching two labials; two sub-

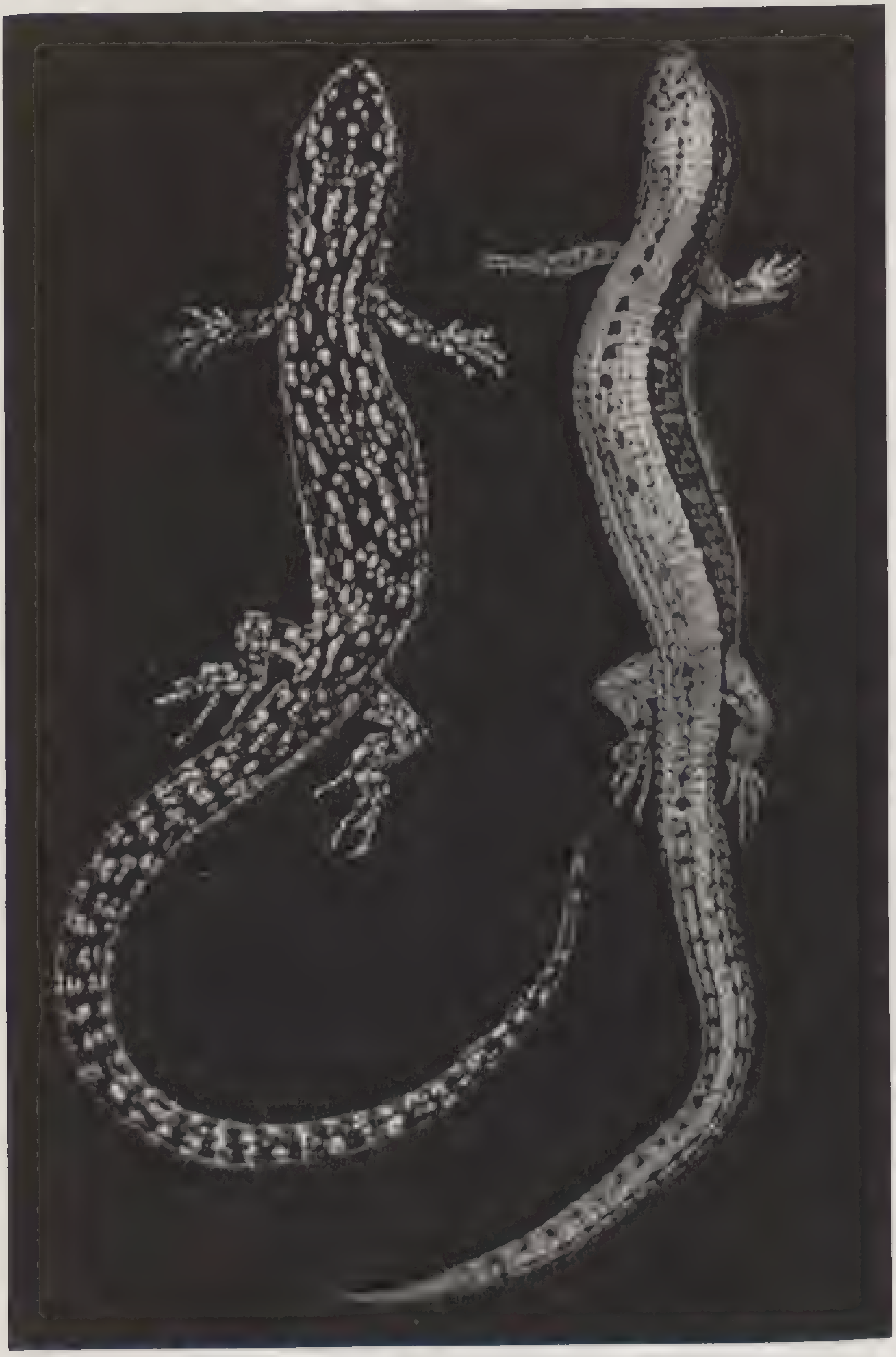

FIG. 54. *Barisia monticola* Cope. KUMNH No. 30800♂, near Empalme, Cartago Province, C. R., elevation 6000-6500 ft.; actual total length, 188 mm.; right figure, KUMNH No. 30803♀.

oculars, the posterior narrow, elongate; two postoculars; three anterior temporals the median largest; four secondary temporals; a scale intercalated between the parietal and last supraocular; supralabials nine, the sixth smallest, below middle of eye; infralabials seven or eight; mental narrower than rostral but having a longer labial border; an azygos postmental touching one (two) infralabials; three large paired chinshields, the first pair in contact, touching two labials; second pair touches one labial and is partially separated from it by an intercalated scale, a part of a series that also separates the third pair from the labials; auricular opening as large or larger than eye-opening; a granular area behind ear consisting of seven or eight rows of irregular-sized granules; deep groove from axilla to groin with four or five rows of small granules. Dorsal body scales smooth on nuchal region, the scales in eight large rows and two short rows of much smaller scales, one on each side; scales at middle of body in 16 rows on sides and dorsum, and in 12 rows on venter; two median nuchal rows are replaced on the back each by two rows which are keeled, and somewhat farther back the adjoining lateral row is also keeled; rows about base of tail, 22; scales in transverse rows from occipital to above vent, 45; scales from vent to first chinshields, 52; subcaudal scales, 83; at base of tail six dorsal caudals with strong keels, posteriorly four rows keeled.

Arms and legs, when adpressed, overlap about two or three millimeters; arm covered dorsally with five rows of enlarged flat scales; underside with small tubercular juxtaposed scales, which are also extended on palm. Lamellae under fourth finger, 13-13; about six rows of flat scales on top and front of thigh; the lamellae under fourth toe, 16-19. Vent bordered anteriorly by about five scales.

Color in life ♂: Above deep black with greenish yellow flecks on each scale, the flecks tending to form discontinuous dorsolateral lines, and elsewhere dashlike marks of varying length also having a linear arrangement; on head each scale with a greenish dot, and on tail the dots are arranged transversely, tending to give the tail a banded appearance; some 38 caudal bands can be discerned. Venter, chin, and throat gray, with numerous black spots and flecks, none as large as a whole scale. A light line below eye to ear.

The female (KUMNH 30803) is uniformly brown above with a series of black dots forming a discontinuous dorsolateral line covering parts of two scalerows, and continuing on to base of tail. A few black or dark brown flecks on sides, darker and lighter flecks on head; a row of black flecks on supralabials, others less distinct on infralabials. Venter with the darker coloring in the middle of the scalerows, the outer edges lighter. The line below eye to ear usually discernible.

Measurements in mm.: Snout to vent, 70; tail, 118; length of head, 17; width of head, 12.6; snout tip to ear, 14; snout to arm insertion, 24; arm, 18.2; leg, 20.5.

Variation: Series are available from four localities: near Vara Blanca, Heredia Province; Cerro de la Muerte, San José Province; Volcán Irazú; and a smaller lot from the Bosque Nacional. While there are scale differences, I believe that in no case are the variations constant. The population at Vara Blanca, a locality north of the divide between Volcán Poás and Volcán Barba, has a rather high percentage of divided frontals. However the division is generally anomalous since the division may be in the anterior part of the scale or just back of the middle, or the scale may be divided into three parts. The prefrontals in the various populations show broad contact, narrow contact, or separation varying in degree.

The combined length of limbs on the average is equal to the distance from axilla to groin in the Vara Blanca specimen (circa 6000 ft. elev.) while, in the Cerro de la Muerte lot, from higher elevation (11,000 ft.), their combined length is two-tenths greater than the distance from axilla to groin.

Females from about Irazú usually have dorsolateral lines of black dots and a median brown line also; those from Vara Blanca often have the dorsolateral series of brown spots, and in one female a bluish-white dorsolateral line was evident and some blue-white flecking on the head. In the Cerro de la Muerte specimens, brown spots and lineation are not evident. The number of scalerows varies around the middle of the body. Specimens from the northern part of the Talamanca range may have 16 dorsal scalerows, the outer rows equal in size to the adjoining ones or only a little smaller.

In various other parts of the range one counts only fourteen dorsal rows of regular size with an outer, usually concealed, row distinctly less than half the size of the adjoining row. On the Cerro de la Muerte farther south in the Talamanca range, and on Volcán Poás many individuals are of this character.

On the whole specimens in the Cordillera Volcanica, which includes the Volcanoes Irazú, Turrialba, Poás and Barba, the males have more numerous greenish-yellow marks on the body, most scales bearing several flecks or dots. (See fig. 55.)

A few other unusual variations occur; specimens are found

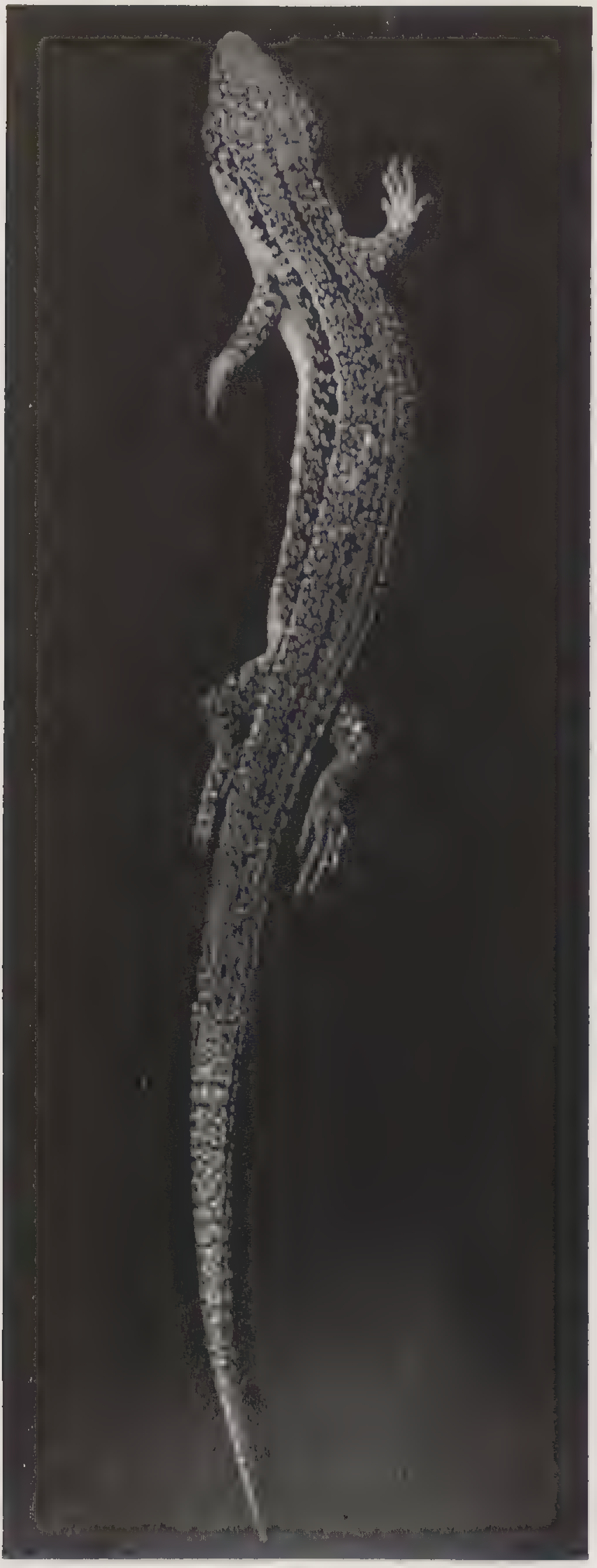

Fig. 55. *Barisia monticola* Cope *var.* KU MNH No. 40117 Cot, southern slopes of Volcán Irazú, Cartago Province, elevation 5700 ft. (Shows distinct variation in color markings. Compare with male, fig. 54). Actual length, snout to vent, 85 mm.; tail 96 mm.

with paired median occipitals; one having a paired postmental; one having the second pair of chinshields broadly in contact mesially. One specimen from Cot, (near Cartago) had 50 scales from occipital to above vent while other specimens varied from 44-48; the scales on the venter, from vent to first chinshield, vary between 49-55 the usual number being about 53. The count of subcaudals is 77 in four specimens with complete tails. Lighter markings on the ventral surface are usually cream or yellowish.

My specimens of *Barisia* from Costa Rica are distributed as follows: Heredia Province: KUMNH No. 36279-36295 near Vara Blanca 6000-7000 ft.; 25606 Volcán Poás, 5 mi. SW Isla Bonita. Alajuela Province: 30791 near Villa Quesada. Cartago Province: 25596-25605, 25607, 30793-30794, vicinity of Hotel Robert, Volcán Irazú; 30795-30796, El Sanatorio, Volcán Irazú; at or near the Bosque Nacional, on Pan-Amer. Highway 7,000-8,000 ft; 40117, Cot.

Family Xantusiidae Baird

Xantusiidae Baird, Proc. Acad. Nat. Sci. Philadelphia, 1858, p. 254.

Only a single genus, *Lepidophyma,* is known in Costa Rica.

Genus Lepidophyma A. Duméril

Lepidophyma A. Duméril, in Duméril and Duméril, Catalogue méthodique de la collection des reptiles (Paris Museum), 1851, pp. 137-138 (type of genus *Lepidophyma flavimaculatus* A. Duméril, by monotypy); Cope, Proc. Acad. Nat. Sci. Philadelphia, 1883, p. 30.

Poriodogaster A. Smith, *in* Gray, Proc. Zool. Soc. London, 1863, p. 154 (type of genus *Poriodogaster grayii* Smith, by monotypy).

Akleistops Müller, Verh. naturf. Ges. Basel, vol. 6, 1878, p. 390 (type of genus, *Akleistops guatemalensis* Müller, by monotypy).

Description of genus: Body and tail rather rounded; head widened posteriorly; eye without distinct eyelids; no teeth on palate; scales of head thin, smooth except for minute tubercular rugosities; nostril surrounded by three scales. Frontal very large, divided mesially; no supraoculars present; a row of small supraciliaries; lower labials and chinshields completely fused, the labials having the general appearance of chinshields; anterior nasals forming a median suture; frontonasal, frontoparietals, interparietal (bearing an eyespot), and parietals present; three enlarged temporals. Body covered on sides and back with granules intermixed with transverse (vertical) rows of larger conical trihedral or irregular tubercles; a pair of longitudinal tubercular rows dorsally; tail segments covered with transverse rows of complete or partial annuli; venter with quadrangular scales in transverse and longitudinal rows; throat covered with subequal granules; a nuchal fold; usually a longitudinal fold from behind ear on side of neck and also a pair of shorter folds on neck.

The genus has entered Costa Rica from the north along both coasts and has extended itself at least to the Canal Zone in Panamá. The literature references of the genus in lower Central America are few. In some cases the southern specimens have been referred to *Lepidophyma flavimaculatum* A. Duméril. The following have been reported: one from Honduras (Werner 1896); one from Nicaragua (Río Mico, Caribbean drainage, Gaige, Hartweg and Stuart); none reported from Costa Rica; one from Panamá (referred to *Poriodogaster grayii* Peters 1874); one from Río Chilibrillo, Panamá and one from Barro Colorado I., Canal Zone (Barbour 1924, described as *L. f. obscurum*).

On the whole the genus is a conservative one and for the most part the general body form and general coloration remain the same throughout. However, certain characters are affected by evolution, producing differences worthy of nomenclatural recognition. At the same time other, perhaps major characters, may be variable within specialized populations.

One of the difficulties in studying the genus in Central America is that only in a few cases are adequate museum series available from any locality.

The specimens from Costa Rica in my collection number 58, of which 19 are from six localities in the Caribbean drainage; while 39 are from five localities in the Pacific drainage area.

The Costa Rican specimens are regarded as belonging to three forms, two presumably confined to the western, Pacific drainage, and one to the eastern, Caribbean drainage. They are lowland forms, none having been found above an elevation of 3,000 feet. It is doubtful that any of the forms are completely isolated geographically. Two of them occur at Tilarán, Guanacaste.

Mertens (1952) has recently reported *Lepidophyma smithi smithi* Bocourt from El Salvador. While he does not describe the conformation of the squamation in detail he does give the following significant information:

1. A median prefrontal present (one case a double scale).
2. Three scales between the whorls of larger caudal scales (four to a segment).
3. Femoral pores (1 specimen) 5-7.
4. Four dark longitudinal bands on a brown ground color on which are rows of yellow flecks.

5. Chin region of all with darker markings.

Mertens had four examples, the largest having a snout-vent length of 66 millimeters, the tail 101 mm.; the smaller specimens 39-42 mm.; and 59-61 mm. respectively.

It will be apparent that the species found in El Salvador differs markedly from the two found in the Pacific drainage of Costa Rica.

KEY TO THE COSTA RICAN SPECIES OF LEPIDOPHYMA

1. Throat region behind chinshields strongly marked with dark brown or black reticulations enclosing rounded cream spots. Second pair of chinshields separated by small scales; postocular scales wider. First loreal higher than second nasal, no trace of lateral stripe; 15-17 femoral pores; Pacific drainage.......... *Lepidophyma reticulatum*

   Throat region behind chinshields lacking definite reticulations, the area usually light with nearly equal distribution of pigment, or a few light brown dots; second pair of labials forming a median suture; anterior loreal lower or higher than posterior nasal; postocular scales narrower 2

2. Femoral pores 13-15; a pair of postparietals or partial sutures marking the same; first loreal higher than the posterior nasal. Caribbean drainage .... *Lepidophyma obscurum*

   Femoral pores 16-18; no trace of postparietals or partial sutures marking same; five transverse complete or partial caudal annuli dorsally on each segment of tail; posterior nasal higher than first loreal, which is separated from frontonasal. Pacific drainage, *Lepidophyma ophiophthalmum*

It is probable that future collections may show that part or all of these forms are subspecies. It is not impossible that *Poriodogaster grayii* A. Smith may eventually prove to be identical with one of the forms listed here.

Taylor (Univ. Kansas Sci. Bull., vol. 37, pt. 1, 1955, pp. 547-561), has discussed the central American *Lepidophyma*, and the discussion is not repeated here.

Lepidophyma reticulatum Taylor

(Fig. 56, 57, 58)

Lepidophyma reticulatum Taylor, Univ. Kansas Sci. Bull., vol. 37, pt. 1, 1955, pp. 551-554, fig. 14 (type locality, Agua Buena, Puntarenas Province, Costa Rica).

Diagnosis: Large species with approximately 38 caudal segments; each, except first, with five rows of partial or complete scale annuli crossing dorsal surface of tail (rarely six), the terminal segments not clearly marked; a median prefrontal absent (or present in some specimens in San Isidro del General region); no trace of postparietals; femoral pores in both sexes, 14-17 (average 15.4); the first loreal higher than posterior nasal and touching frontoparietal; only first pair of chinshields in contact behind mental. Throat strongly reticulated with dark blackish brown, enclosing cream spots; scales with small glandular pores.

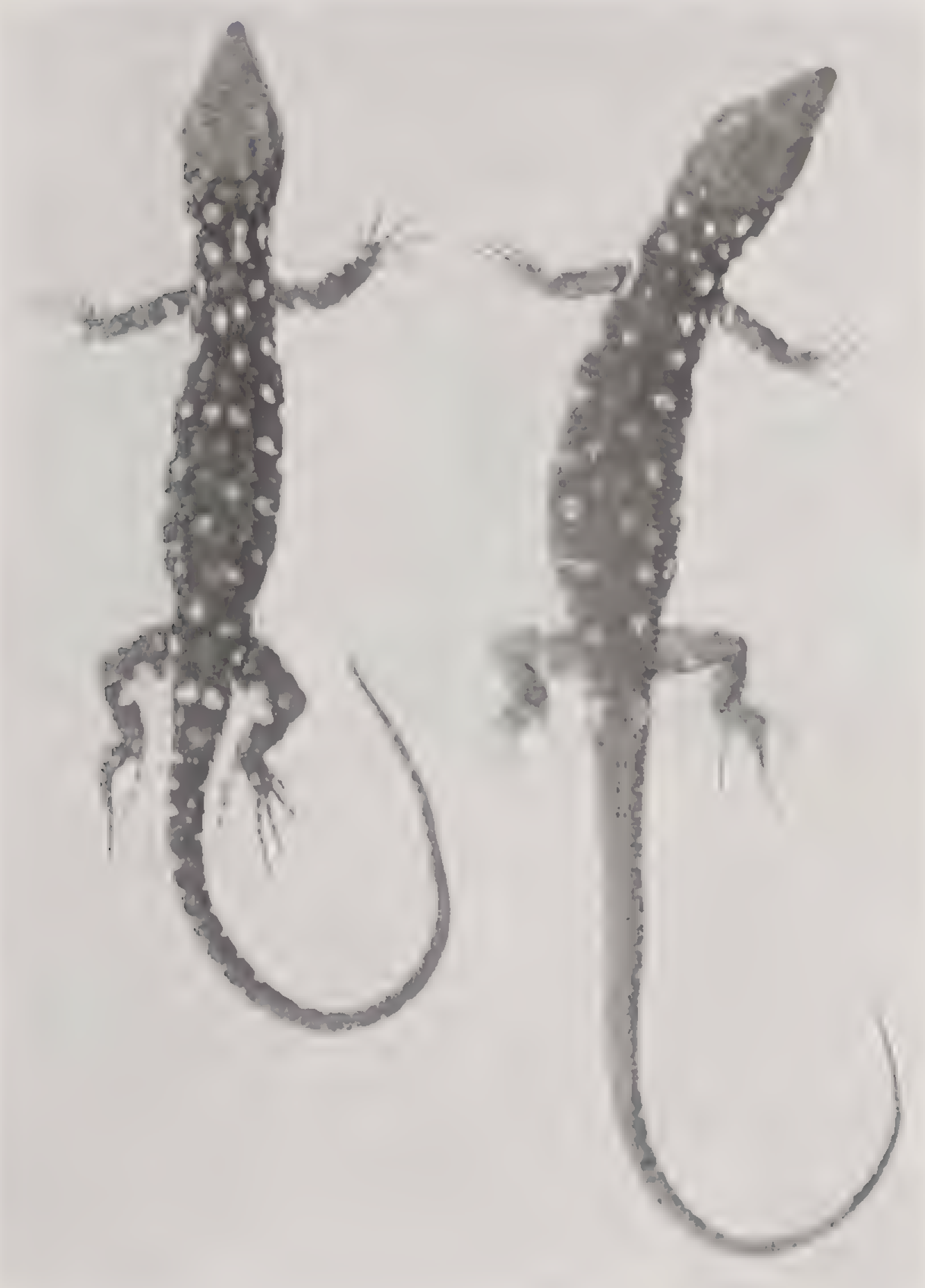

FIG. 56. Left figure, *Lepidophyma obscurum* Barbour. KUMNH No. 34207, (type of *L. anomalum* Taylor), Los Diamantes, Guápiles, Limón Province; right figure, *Lepidophyma reticulatum* Taylor, KUMNH No. 34194, 10 mi. SW San Isidro del general, San José Province or Puntarenas Province.

Description of type: Head nearly triangular seen from above; snout rather pointed, the rostral wider than high, narrowly visible above; anterior nasals broader than high, forming a median suture; frontonasal eight-sided, broader than long; two prefrontals, their outer edges bent down over canthus rostralis, smaller than the divided frontals; outer edges of frontal separated from orbit by a small row of supraciliaries; no supraoculars; interparietal slightly wider anteriorly than posteriorly, pushing in between posterior part of frontal scales, separating broad frontoparietals completely, and touching both parietals; latter longer than wide, bordered laterally by two temporals, the anterior of which is more than double size of posterior; nostril surrounded by three scales: first labial, anterior and posterior nasals; first loreal higher than nasals, its length about one third the length of the second loreal which is nearly as high; two presuboculars and a very narrow linelike preocular; five supraciliaries; five postoculars; two minute suboculars separate fifth supralabial from the orbit; first upper temporal twice as wide as postoculars; lower small; between sixth and seventh labials and second upper temporal two rows of small temporal scales; seven supralabials, followed by two small scales separated from mouth by granules; a row of somewhat larger tubercles border edge of ear opening, and these preceded by two or three still larger moundlike scales; infralabials (fused labials and chinshields) four, only the

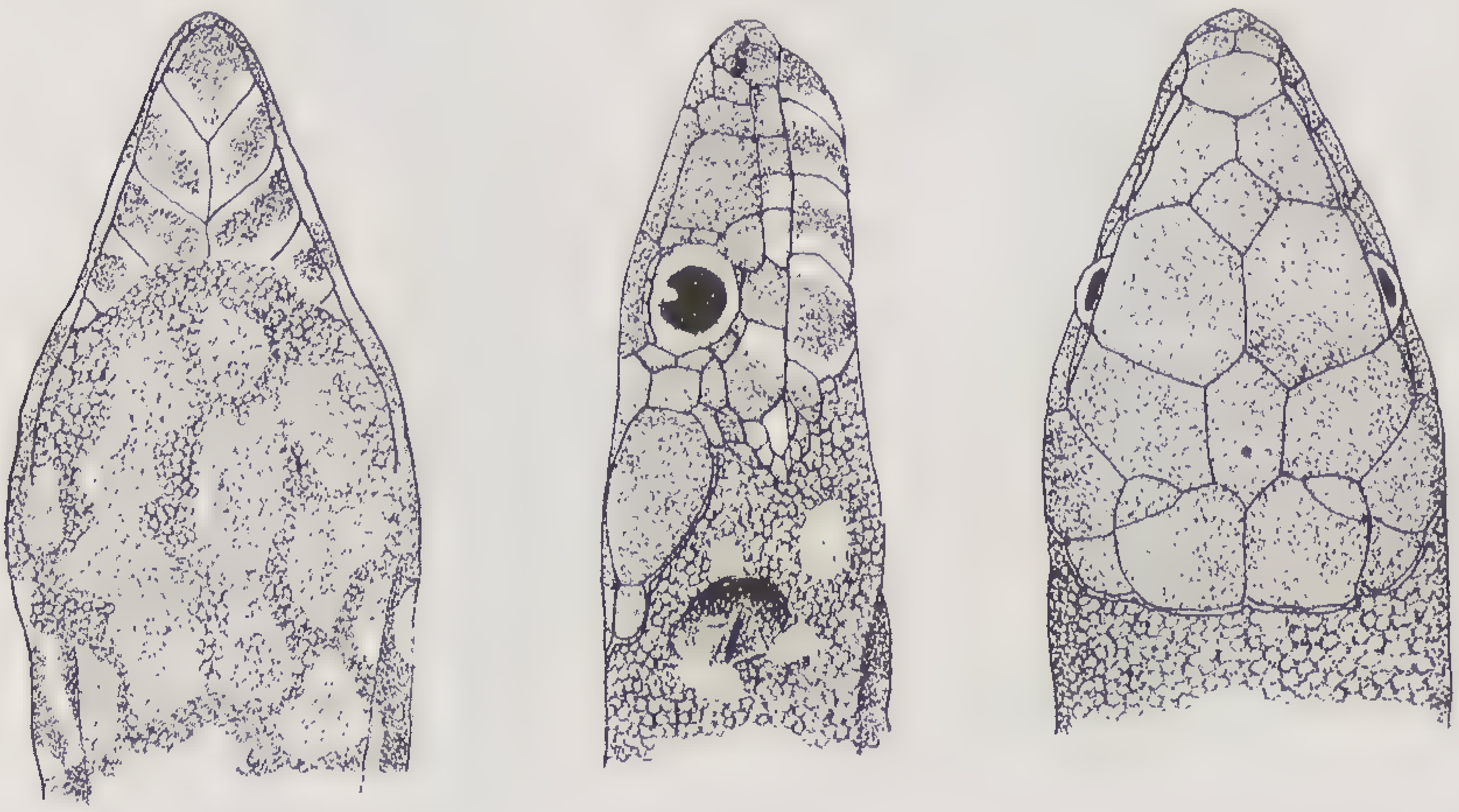

FIG. 57. *Lepidophyma reticulatum* Taylor. RCT No. 867, 2 mi. E San Isidro del General, San José Province. Note unusual condition of the parietal (divided); (enlarged).

first pair in contact mesially; second pair largest, narrowly separated; fourth about one-fifth times as large as third; posterior part of lower lip bordered by several granules; mental large, its labial border three times that of rostral; on throat and sides of neck, conical granules; ear-opening large, its greatest diameter approximately 4 mm.; vertical diameter of orbit, 3 mm.; length of eye to tip of snout, 7.5 mm.; distance from orbit to ear opening 8 mm.; a pair of ventral longitudinal folds on neck; a pair of short lateral folds running back from ear; a transverse nuchal fold present.

Body covered with small conical or moundlike granules intermixed with larger conical trihedral or irregularly shaped tubercles that tend to form vertical rows on sides of body; a pair of longitudinal rows on dorsum separated from each other by four or five rows of granules; tail segments marked by series of annular rings of scales increasing in size posteriorly; the first, often second, each with a large tubercular whorl and these preceded by two small granular rows; first typical segment with five partial or complete annular scale rings, the scales growing larger towards the ventral surface so that the median part of each segment has only three scales; tip of tail regenerated in type. Scales on limbs varied in size, the hind leg especially with numerous larger tubercles; palm and sole with somewhat conical granules; digits with varied scales on ventral surface; those on proximal regions conical or trihedral; in median parts digital lamellae divided unequally; distally they are complete or an occasional one divided.

Scales on breast, flat, subimbricate, becoming elevated laterally; venter with flat juxtaposed scales arranged in eight longitudinal rows, with an addition of a partial lateral row of more elevated scales on each side; about thirty transverse rows from axillary level to the inguinal level.

Scales on under side of thigh somewhat subimbricate anteriorly; femoral pores 17-15; two pairs of large (slightly irregular) preanal scales, preceded by a very small pair.

Color in life: Head brown with some indefinite dark marks tending to form a somewhat radiating symmetrical pattern. Supralabials with cream marks on sutures; infralabials each with a large black spot or diagonal bar bordered by cream; throat strongly reticulated with brownish black enclosing cream spots. On side of head and neck rounded cream spots surrounded by black; body black on back and sides with six longitudinal series of irregular cream spots; arms and legs with a few conspicuous cream spots. A pair of larger cream spots on tail above vent; segments of tail with a series of vertical cream lines chiefly on the largest scales series; median part of dorsal surface black; ventral surface with cream predominating anteriorly and black posteriorly; femoral pores and adjoining scales cream; venter dirty cream with some dark flecks along ventrolateral region; fingers and toes ringed with cream; anal scales bluish white.

Measurements in mm.: Snout to vent, 92; tail, 120; length of head, 20; width of head, 16.2; snout to arm, 33; axilla to groin, 45; arm, 30; leg, 41.

Variation has been discussed by Taylor, *loc. cit.*

The species is known from the following localities: Puntarenas Province: Agua Buena, San Isidro del General. Guanacaste Province: Tilarán.

Lepidophyma obscurum Barbour

(Fig. 56)

Lepidophyma flavomaculatum obscurum Barbour, Proc. New England Zool. Club, vol. 9, Jan. 4, 1924, pp. 9-10 (type locality, Río Chilibrillo, Panamá); Burt, Trans. Amer. Micro. Soc., vol. 54, 1935, p. 174 (Panamá).

Lepidophyma anomalum Taylor, Univ. Kansas Sci. Bull., vol. 37, pt. 1, 1955, pp. 554-558, fig. 14 (type locality, Los Diamantes, Guápiles, Limón Province, Costa Rica).

Diagnosis: A large species with approximately 35 caudal segments, the basal seven to twelve with four complete or partial annuli dorsally; the segments following, with five annuli; three or four terminal segments not clearly differentiated; a median prefrontal normally present; first two pairs of infralabials in contact behind mental; femoral pores in males and females 13-15 (average about 14); throat cream with a few tiny scattered brown dots, the size of the scales between neck folds, but no reticulation of black or brown and no cream spots; usually a pair of postparietals completely or partially segmented from parietals; most body and caudal scales each with a small glandular pore. Two dorsal rows of light tan spots; lateral spots cream.

Description of type of anomalum: Head, seen from above, subtriangular, pointed anteriorly, the border of the head plates tending to be slightly angular on the occiput; a slight median longitudinal depression in the parietal region; rostral wider than high, angular medially; anterior nasals form a median suture about two thirds the greatest width of the scale; frontonasal eight-sided, wider than long, touching first loreal; three prefrontals, the median little more than one-third times the area of the outer scales; frontal divided mesially, separated from orbit by the supraciliaries, angular posteriorly; interparietal subhexagonal, bearing an eye-spot, only slightly wider anteriorly, somewhat narrowed near the middle, separating completely the frontoparietals; latter scales with their long axis diagonal, touching one supraciliary, one postocular and two temporals; parietals distinctly longer than wide; postparietals only partially indicated by a pair of grooves directed diagonally backward from the sutures with the interparietal; second nasal much higher than first, much higher than long (wide), not as high as second loreal, not separating it from frontonasal; first loreal as high as second but only half its length (width); a slender linelike preocular four times as high as wide; one presubocular; four narrow postoculars and five small supraciliaries; first temporal much wider (4 times) than adjoining postoculars; second temporal large, about five times area of first temporal, about four times area of second; eight supralabials, first high, forming with the nasals, the border of nostril; fifth below eye and separated from the orbit by a linelike scale, sixth largest, touching two or three postoculars but separated from the first and second temporals by one or two rows of granular temporals; last labial very small; three anterior infralabials (fused labials and chinshields) large, both forming median sutures, the second pair partially separated on the median line; last two small with two differentiated scales bordering them; mental large, angular posteriorly; a small anomalous triangular scale (true infralabial?) lying between the mental and first large infralabial on each side; auricular opening large, with a row of about seven larger tubercles along its outer border, its height four millimeters; orbit of eye circular; no evidence of eyelids; orbital diameter three fourths the height of ear opening; distance between orbit and tip of snout (7 mm.) less than distance between orbit and ear; a pair of longitudinal folds along outer ventral surface of neck; lateral fold from ear to shoulder, and a transverse nuchal fold; body and sides covered with small conical or moundlike granules intermixed with larger conical trihedral, or pyramidal tubercles, the latter forming vertical transverse rows laterally; a pair of longitudinal rows of tubercles on back separated by five rows of subequal granules; chin (partly) and throat covered with subequal granules; breast and venter covered with flat juxtaposed, quadragonal scales, forming ten longitudinal rows; between axilla and groin levels about 27 transverse rows; scales on breast smaller, somewhat irregular; tails with each segment bearing posteriorly a whorl of larger tubercles; on first basal segment the large whorls are separated by two, on second by four smaller whorls, while the following six segments have them separated by three complete or partial whorls; from here on they are separated by four whorls. Thus each segment has either four or five complete or partial whorls dorsally, but ventrally, where the scales are larger there are only two or three.

Arms and legs with granular scales and some intermixed tubercles especially on upper parts of hind leg; those on arm semispinose; some much enlarged scales on outer ventral surface of tibia; subdigital scales may be granular near base, the lamellae tending to be unequally divided except on the distal half. First preanal scales large, longer than wide, bordered by a small scale on each side and preceded by a second pair. These in turn preceded by a row of four scales.

Color in life: Dorsal part of head brown with evidence of some darker marking, the area above eye distinctly darker; body black dorsally with three rows of spots, those on the dorsal surface somewhat indistinct, tan in color; lateral rows of spots brownish cream; venter dark; tail blackish brown with very narrow, vertical lines marking tubercular whorls on sides of tail; a vertical cream line in front of eye; cream dots on supralabial between black spots; infralabials with black spots or bars separated by brownish cream (fawn); chin dirty white with a few fine brown flecks; cream spots present on cheeks and on side of neck; the periphery of ventral scales with much brownish pigment leaving the central part of scales lighter; preanal scales bluish white; subcaudal scales brown, mixed with cream; pore-scales cream; arm and leg blackish brown with some cream spots.

Measurements in mm.: Snout to vent, 96, tail, 137; axilla to groin, 29; arm, 40; leg, 49.

Variation in this form is discussed by Taylor (*loc. cit.*).

The species is known from the following localities: Limón Province: Los Diamantes (Guápiles), Bataan, La Lola, Suretka, and Puerto Viejo. Cartago Province: Morehouse Finca (Turrialba).

Remarks: An examination of the type of Barbour's *obscurum* shows it to have the same curious pair of postparietals segmented from the parietals. These were not mentioned in the type description by Barbour. Other differences such as the reduction of the dorsal spotting of the type may be an individual character. I conclude that *anomalum* is a synonym of *obscurum*.

Burt (*loc. cit.*), states: "The form has no eyelids and no femoral pores. . . ." However, femoral pores *are* actually present in both males and females of *obscurum*. I have not seen Dr. Burt's specimen. It may not belong here.

Lepidophyma ophiophthalmum Taylor

(Fig. 58)

Lepidophyma ophiophthalmum Taylor, Univ. Kansas Sci. Bull., vol. 37, pt. 1, 1955, pp. 558-561, fig. 15 (type locality, 5 km NNE Tilarán, Guanacaste Province, Costa Rica).

Diagnosis: Superficially, closely resembling *Lepidophyma reticulatum* in color and marking. Median prefrontal present or absent; chin lacking reticulation, light colored save for brown dots the size of granules; posterior nasal much higher than anterior, and higher than first or second loreal; first loreal separated from frontonasal; second pair of labials forming a common suture; vertical diameter of ear-opening a half greater than diameter of orbit; frontonasal hexagonal; 35 caudal segments with five complete or partial annular scale rings except terminal three or four where segments are ill-defined and may be reduced to four annuli; parietals proportionally longer and narrower than in *reticulatum,* frontoparietal narrowed laterally where it touches the last supraciliary and upper postocular; first pair of preanal scales bordered laterally by a small preanal; a partial or complete row of small scales between first (larger) and second preanal pair; femoral pores 16-18; anterior temporal distinctly larger than in *L. reticulatum.*

Description of type: Head outline generally triangular seen from above; snout pointed; rostral wider than high rising to a sharp angle mesially, distinctly visible seen from above; anterior nasals wider than high, their inner median height at suture little more than half of outer height at nostril; frontonasal hexagonal, slightly broader than long; two large prefrontals, their outer edges bent down over canthal edge, laterally touching posterior nasal, both loreals, first supraciliary, and preocular; frontals large, their front borders straight, transverse, forming an angle posteriorly; separated from orbit by a row of three or four somewhat projecting supraciliaries; frontoparietals 6-sided, narrowed anteriorly; interparietal wider anteriorly, subhexagonal, separating completely the frontoparietals, bearing an "eye-spot" that is white with a black spot showing in its middle; parietals (6 mm. x 3½ mm.) six-sided; first temporal relatively large (2.5 mm. x 2 mm.); second temporal very large, the third less than one-third times size of second; scales in preauricular region small, variable in size; auricular edge bordered by a row of seven heavier scales nearly hiding another smaller inner row; a pair of longitudinal skin folds on outer ventral surface of neck; a less-distinct fold from behind ear to nuchal fold; a

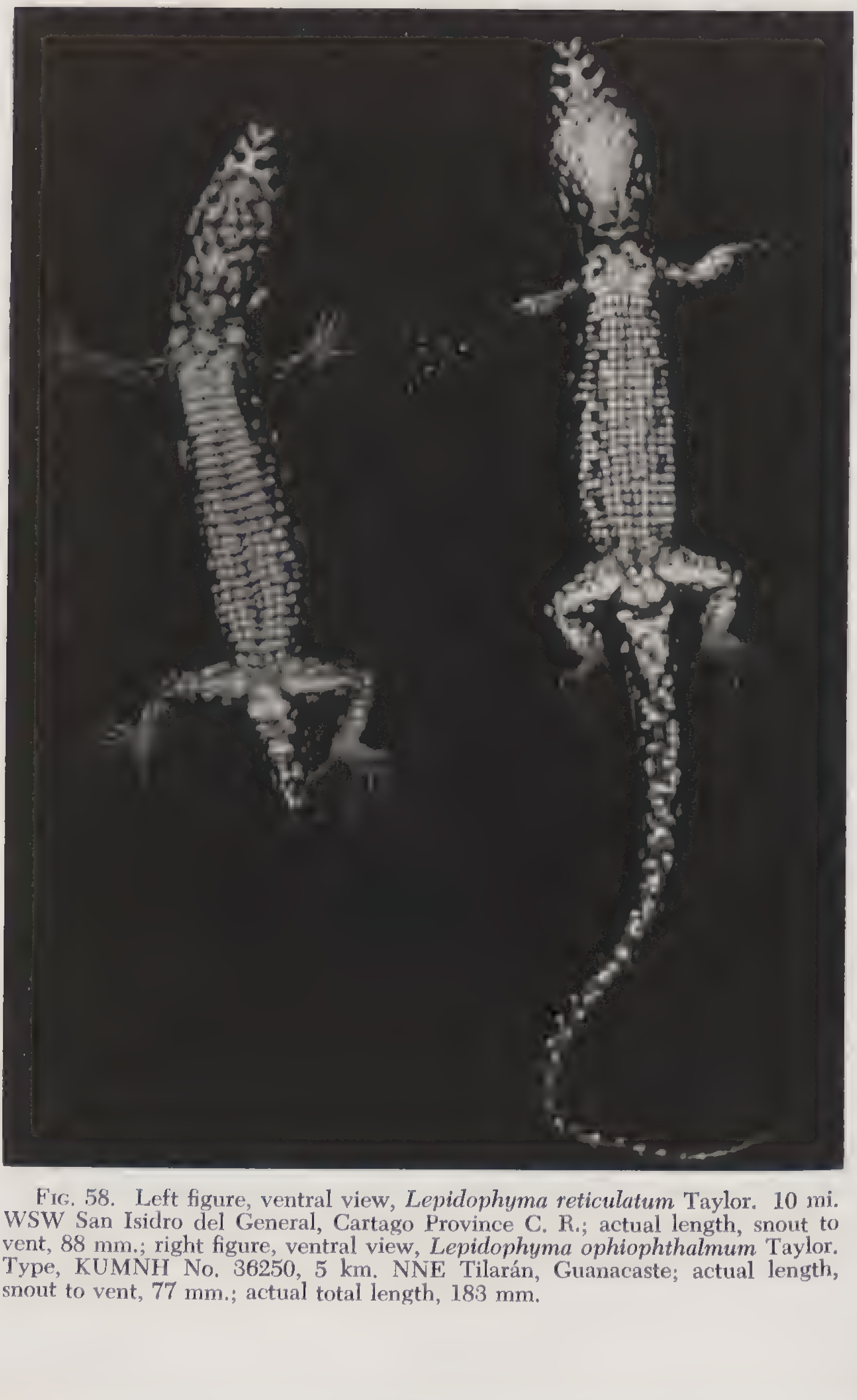

FIG. 58. Left figure, ventral view, *Lepidophyma reticulatum* Taylor. 10 mi. WSW San Isidro del General, Cartago Province C. R.; actual length, snout to vent, 88 mm.; right figure, ventral view, *Lepidophyma ophiophthalmum* Taylor. Type, KUMNH No. 36250, 5 km. NNE Tilarán, Guanacaste; actual length, snout to vent, 77 mm.; actual total length, 183 mm.

transverse nuchal fold. Eye circular without evident lids, the diameter of orbit (2.8 mm.) less than height of auricular opening (3.6 mm.); distance between tip of snout and orbit (6.5 mm.) less than distance between orbit and ear. Body covered with small, conical or moundlike granules interspersed with large conical or trihedral spinelike tubercles forming vertical lateral rows; a pair of longitudinal rows on dorsum, separated from each other by four or five irregular rows of subequal small granules; the large tubercular scales form continuous series around tail, one large series on posterior part of each tail segment. Nostril surrounded by three scales; posterior nasal higher than loreals or anterior nasal, widened at top, separating the first loreal from frontoparietal, touching prefrontal; anterior loreal twice as high as long, one third length (width) of second but nearly as high; a long narrow preocular; one presubocular; three postoculars, lowest largest; fifth labial below orbit, separated from it by two granular scales; sixth labial separated from first two enlarged temporals by a small lower anterior temporal and two granular rows of temporals; first (upper) temporal more than three times width of upper postoculars. Seven supralabials, first reaching up to nostril, sixth largest, nearly twice as long as high; last small, separated from edge of lip; four large lower labials (fused labials and chinshields); two anterior pairs making mesial sutures, the second pair much larger than others; labial border of mental double that of rostral; mental angular posteriorly; posterior part of the mouth-opening bordered by granules. Tail segments approximately 36, each covered with five complete or partial rows of subconical scales, the posterior whorl composed of much larger tubercles; ventrally each segment with three, rarely four scales, larger than the lateral or dorsal scales; arms and legs covered with small granules intermixed with larger ones, some of the scales on under surface of thigh subimbricate; femoral pores 16-16 in small single scales; subdigital lamellae variable sometimes divided or broken up into small tubercular scales at base of third and fourth toes; distal lamellae usually complete; scales on venter flat, quadrangular, subequal except those on breast which are smaller, arranged in 10 longitudinal rows and 26 transverse rows from level of axilla to level of groin; on part of the transverse rows one counts 12 scales, but the outer row on each side is irregular, variable, the scales not flat. Most, if not all scales on body and tail with pores (or glands) visible under magnification. Preanal scales consist of a posterior row of two much enlarged scales and two smaller lateral scales; median row broken, leaving the third pair on left side touching a large posterior scale; third row has two scales larger than those in median row.

Color in life: Head brownish with some indefinite darker marking; black spots on loreals and supralabials separated by small cream spots; infralabial and mental with dark bars, separated by white; chin dirty white with a few brown granules; sides of neck with large cream spots on black background; body black with six irregular rows of lighter spots; venter scales heavily dusted with brown leaving a whitish central area on each; outer rows of ventral scales with a nearly continuous irregular white line; femoral pore-scales white. Arms and legs spotted white; tail with irregular white spots on sides, one to each segment, variable in size and position; under side of tail blackish with some scattered white scales; preanals bluish white.

Measurements in mm.: Snout to vent, 77; tail, 106; head width, 13.8; head length, 18; snout to foreleg, 31; snout to ear, 18.5; axilla to groin, 36; arm, 23.5; leg, 35.

Variation is discussed by Taylor (*loc. cit.*).

The species is known from the following localities: Guanacaste Province: Tilarán and Las Flores (Tenorio, Las Cañas).

FAMILY TEIIDAE Cope

Teiidae Cope, Proc. Acad. Nat. Sci. Philadelphia, 1864, p. 229.

This family presumably of South American origin has representatives of at least six genera in Costa Rica. The following are known: *Anadia, Gymnophthalmus, Ptychoglossus, Leposoma, Ameiva* and *Cnemidophorus.* Another genus, *Echinosaurus* enters Panamá from South America and may eventually be found in Costa Rica. I recently (1949) described a Costa Rican form under the genus *Alopoglossus.* Ruibal (1952) has revised and redefined this genus, and the species, *A. plicatus* is referred tentatively to the genus *Ptychoglossus.* I so treat it in this present work.

KEY TO GENERA OF TEIIDAE IN COSTA RICA

1. Body covered with enlarged scales that are imbricate or juxtaposed, smooth or keeled 2
   Body generally on dorsum and sides covered with small granular or conical juxtaposed tubercles 5
2. Four fingers, five toes; eyelids absent; no gular fold or collar. *Gymnophthalmus*
   Five fingers, five toes, eyelids present. With or without collar 3
3. Head scales with longitudinal striations; frontonasal divided (Costa Rican forms); no gular fold or collar . . . . *Leposoma*
   Head scales without longitudinal striations; frontonasal single 4

4. A divided transparent disc on lower eyelid; dorsal scales juxtaposed or slightly imbricate; body slender; tail cylindrical long; nostril in single nasal (Costa Rican forms) . . . . *Anadia*

   No distinct transparent disc in lower eyelid; body not slender, elongate; tail not cylindrical; dorsal body scales distinctly imbricate; nostril between two nasals . . . . *Ptychoglossus*

5. Scaly part of tongue not bifid; usually a sheath between larynx and scaly part of tongue and a dermal fold present at sides of base of tongue . . . . *Ameiva*

   Scaly part of tongue bifid posteriorly; not sheathed . . . . *Cnemidophorus*

Genus GYMNOPHTHALMUS Merrem

Gymnophthalmus Merrem, Tentamen systematis amphibiorum 1820, p. 74 (type of genus, *Lacerta quadrilineata* Linnaeus = *lineatus* Linnaeus).

Blepharactisis Hallowell, Proc. Acad. Nat. Sci. Philadelphia, 1860, p. 484 (type of genus, *Blepharactisis speciosa* Hallowell).

Epaphelus Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1876 (1875), p. 115 (type of genus, *Epaphelus sumichrastii*, presumably from Tehuantepec, Mexico).

Description of genus: A genus composed of a group of small, skinklike lizards having the scalerows around middle of body varying from 13 to 17; head small, covered with regular smooth scales; frontonasal separating nasals; prefrontals present; nostril pierced in nasal; eyelids absent, ear-opening present; limbs well developed, four fingers, five toes all with claws; scales subhexagonal, imbricate, with or without weak keels; strong keels present on caudal scales in some forms; no gular fold; tail elongate, cylindrical, usually colored differently from body; males with small femoral pores; the teeth generally cone-shaped; distal part of tongue covered with pigmented scalelike plicae, except at bifid tip.

Blepharactisis speciosus Hallowell, was described as a scink in 1860 from Nicaragua. Cope (1870) described *Tretioscincus laevicaudus* from Occidental Department, Nicaragua, and later (1875) described *Epaphelus sumichrastii* presumably from the Tehuantepec region of Mexico; but later (1877) he synonymized the two. Cope refered them then to the family Scincidae. Burt (1931) and Burt and Burt (1933) followed Cope in synonymizing *Gymnophthalmus laevicaudus* and *sumichrastii* but failed to note the relationship of these nominal species with *Blepharactisis speciosus* Hallowell.

Stuart reviewed the genus in 1939, and described a new species, *Gymnophthalmus birdi*, from Guatemala. He recognized six other species in the genus, two occurring in Central America—*Gymnophthalmus speciosus* (Hallowell) and *Gymnophthalmus sumichrastii.*

Mertens (1952) regarded *speciosus* Hallowell as the proper specific name; however he reduced Stuart's *Gymnophthalmus birdi* to subspecific status—an action that may be questioned if it can be shown that the characters of *birdi* are constant.

The total number of Central American specimens of this genus in collections is still very small. Perhaps with the acquisition of larger series our present concepts of the species may require some revision.

The Costa Rican material available here consists of three specimens (KUMNH Nos. 34220-22) taken at Palmar, Puntarenas Province, one (No. 10643) 4 mi. N Barranca in the northeastern part of Puntarenas Province, and one (No. 11210) from 3 km. ESE Los Angeles (between Tilarán and Cañas) southeastern Guanacaste Province. It is presumed that only a single species occurs in Costa Rica.

Gymnophthalmus speciosus speciosus Hallowell

Blepharactisis speciosus Hallowell, Proc. Acad. Nat. Sci. Philadelphia, 1860, p. 484 (type locality, Nicaragua); Cope, U. S. Nat. Mus. Bull. 32, 1887, p. 47 (in the family Scincidae).

Epaphelus sumichrastii Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1876 (1875), p. 115, (type locality, Tehuantepec, Mexico) (in family Scincidae).

Tretioscincus laevicaudus Cope, Proc. Amer. Philos. Soc., vol. 11, 1870, p. 557 (type locality, Occidental Department, Nicaragua); Ann. Rept. Trustees Peabody Acad. Sci. 1869, 1870, nos. 2 and 3, 1871, p. 80; Boulenger, Catalogue of the lizards in the British Museum, 2nd Ed., vol. 2, 1885, p. 426; Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Aug. 1885, p. 29.

Gymnophthalmus sumichrasti Bocourt, Mission Scientifique au Mexique et dans l'Amérique Centrale; Études sur les reptiles, livr. 7, 1881, pp. 471-472, pl. 20H, fig. 2, a-i; Boulenger, Catalogue of the lizards in the British Museum (Natural History), vol. 2, 1885, pp. 428-429 (Guatemala and Venezuela, [in family Teiidae]); Günther, Biologia Centrali-Americana; Reptilia and Batrachia, 1885, p. 29; Ruthven, Misc. Publ. Mus. Zool. Univ. Michigan, no. 8, 1922, p. 64; Werner, Zeitschr, Wiss. Zool., Bd. 125, 1925, p. 539; Schmidt, Field Mus. Nat. Hist., Zool. ser. vol. 12, no. 17, Nov. 21, 1928, p. 198 (San Jose del Sacaré, 3,600 ft., Dept. Chalatenango, Salvador; Stuart, Occ. Papers Mus. Zool. Univ. Michigan, no. 409, June 30, 1939, pp. 5-6 (unites *laevicaudus* with *speciosus* Hallowell, but keeps *sumichrastii* as a separate species).

Gymnophthalmus laevicaudus Cope, U. S. Nat. Mus. 32, 1887, p. 46 (*part.*) (type locality Occidental Department, Nicaragua); Burt, Bull. Amer. Mus. Nat. Hist., vol. 61, 1931, pp. 339-341; Burt and Burt, Trans. Acad. Sci. St. Louis, vol. 28, no. 1, Aug. 1, 1933, p. 65.

Gymnophthalmus speciosus Stuart, Occ. Papers Mus. Zool. Univ. Michigan, no. 409, 1939, pp. 4-5 (synonymizes *Tretioscincus laevicaudus*).

Gymnophthalmus speciosus speciosus Mertens, Abh. Senckenb. natur. Gesells., Nr. 487, S. 56, Taf. 13, Fig. 77.

Diagnosis: A small slender scinclike lizard with generally smooth, shiny, imbricate scales, except for keeled scales on terminal portion of tail; four or five supralabials to posterior level of eye, with a total of seven or eight; four large infralabials followed by one or two tiny scales; scales about middle of body, 13 to 15; usually gray with metallic reflections above and tending to form a lighter line on the dorsolateral scalerow, which continues on head, canthus, and snout.

Description of species (From KUMNH No. 34220 Palmar, Puntarenas Province, Costa Rica): Head rather short, snout truncate; rostral prominent, the part visible above nearly half width of frontonasal; frontonasal bordered laterally by nasal and anterior loreal; prefrontals forming a median suture equal to that with small frontal but larger than sutures with frontoparietal or anterior loreal; frontal narrowly in contact with much-enlarged interparietal, the sutures with frontoparietals larger than those with prefrontals; major portion of supraoculars lie anterior to front line of eye; parietals large, widely separated by interparietal; the two following scales transverse, each pair separated by a small scale, may be regarded as occipitals or nuchals.

Nostril pierced in a single nasal having shape of a parallelogram; anterior loreal touches second labial and prefrontal; second loreal smaller than first; preoculars one (two), three or four postoculars; subocular very elongate, curving; supralabials, 7-8; four large infralabials followed by two small partly concealed scales; eye without lid, partly bordered by a narrow rim of minute scales; ear-opening large, less than half eye diameter; temporals, three pairs; mental with a larger labial border than rostral; postmental large, single; two pairs of large transverse chinshields; tongue elongate, bifid, sharply pointed anteriorly, covered with imbricating scalelike plicae that posteriorly form chevrons pointing forward; plicae containing dark pigment.

Scales on dorsum arranged in three longitudinal rows, the median much smaller than other two; 38 scales between parietal to a point level with the hinder side of thighs; four ventral rows posterior to the specialized scales across breast; four lateral rows except in axillary and postaxillary region where one or two more rows of small scales are added; ten scales in a row between last chinshield and the series across breast; 15 scales about body; vent preceded by three large scales and two small (lateral) scales; a large scale preceding the median preanal; subcaudal scales 81, all those approaching tip, keeled; nine rows of scales around cylindrical tail for the greater part of its length; scales on under surface of limb large, those on dorsal and posterior parts much smaller; four fingers, five toes, all bearing claws; twelve lamellae under two median fingers, 16 lamellae under fourth toe; a small depression in axillary region suggesting an incipient pocket.

Color in life: Above generally grayish, or somewhat brownish gray, with some metallic reflections, the color sharply limited on the middle of second (from median) lateral scalerow, the upper part of each scale of this series bearing a more or less distinct light ultramarine spot; these together giving a suggestion of a line that follows side of head and canthal region to tip of snout; sides black, the scales gradually acquiring some grayish dots or borders; chin partly creamy white; tail generally pinkish to orange red, with slight darker pigment on top and sides and much more on ventral surface; on ventral side of tail two more or less well-defined unpigmented lines near base, but these are lost on second distal third of tail; limbs dark and digits above barred with gray and black. Supralabials dark, bordered on edge of lip by a cream line.

Measurements in mm.: Total length, 122; snout to vent, 43.2; tail, 78.8; snout to arm insertion, 14; axilla to groin, 24.5; arm, 9.2; leg, 12.

Variation: Two specimens, KUMNH Nos. 34221 ♀ and 34222 ♂, differ from the described specimen. In both the pigment on the underside of the tail is almost totally lacking. On each side of the tail, there is a moderately distinct stripe with less pigment, extending nearly to the termination of the tail. It is possible that this difference is due to age, since these are smaller and presumably younger. However, this same character is dimly discernible in the described specimen.

Number 34221 has a considerable part of the tail regenerated. The scales of the regenerated part are peculiar in that they are elongate and parallel-sided, each whorl with a single series of 20 scales save near the tip, thus, double the number surrounding the original tail. Moreover, all the scales are seemingly juxtaposed and keeled. This squamation resembles that of certain other genera of Teiidae and suggests a clue to relationship.

The described specimen has seven or eight dark supralabials, the labials having a white edge bordering the lip. No. 34222 has eight labials on each side (five anterior to the back level of the eye). No. 34221 has seven on each side, four anterior to the back level of eye. These also have the white lip border. The described specimen has 15 scalerows around the body the other two definitely have only 13 except anteriorly near the axilla, where more can be counted.

The more northern specimens are smaller. No. 10643 is darker dorsally and has eight supralabials (on one side the second labial is only a small triangular fragment from the first labial). In No. 11210 there are only seven supralabials. In both there are 15 scalerows. There is no trace of the white lip border in either.

Remarks: There is some question about the type locality of *Epaphelus sumichrastii.* In the type description Cope implies that it is from Tehuantepec but it is described in a paper dealing with Costa Rican collections. Bocourt (1881) says that there are two specimens in the Paris Museum that came from Occidental Guatemala as does the type described by Cope. Cope (1887) mentions only Tehuantepec and W. Nicaragua (p. 46) the latter presumably the type locality of *Tretioscincus laevicaudus* Cope.

Specimens at Palmar were discovered by digging extensively around the base of a large tree in a meadow. The specimens were ensconced underground in sandy soil at a depth of one and one-half inches. They moved with considerable rapidity for such slender, shortlegged, animals.

Little is known of their general behavior. The specimen taken north of Barranca was dug from debris left from a rotting brush pile. Another specimen seen at this locality escaped. The specimen taken in the Sierra de Tilarán near Los Angeles was under a small rock near a larger boulder in open grassland.

The femoral pores are four in the southern Palmar specimens but the Los Angeles specimen has six pores and seemingly these differ somewhat from the pores in other specimens.

The species, as now understood, ranges from Tehuantepec to Colombia. Record of the species in Chile (Burt 1931) should be verified by new material. For a small burrowing lizard of small vagility, even the range south to Colombia is remarkable. Ruthven, 1922, notes a Colombian specimen with caudal scales keeled at the base of the tail. He points out variation in the number of the dorsal scales and states that Colombian specimens have 13 or 15 scalerows around the body, variation also evident in the Costa Rican specimens. Ruthven reports the species from the following Colombian localities: Valencia, Badillo, Bolivar, 500 ft., and Tucurinca.

Genus Leposoma Spix

Leposoma Spix, Animalia nova sive species novae lacertarum, Brasil, 1825, p. 24 (type of the genus, *Leposoma scincoides* Spix, by monotypy).

This genus, consisting of seven species (*fide* Ruibal), having a distribution chiefly in northern South America, has at least one species entering Costa Rica.

Description of genus: Head with large regular shields, most of which are ridged or striate; frontonasal divided separating the nasals; prefrontals and frontal present; nostril in nasal usually partly divided or grooved; interparietal as large as or larger than parietals; no specialized postparietal or occipital scales; dorsal and lateral body scales keeled mucronate arranged in transverse and oblique rows; scales on venter strongly mucronate, keeled, or smooth, the scales arranged in longitudinal and transverse rows; one azygous postmental followed by two or three pairs of chinshields; eye with an opaque or transparent area divided into two to four parts; collar if present, scarcely discernible; tongue covered with scales or scale-like plicae (not papillae); femoral and preanal pores in male; female without femoral pores, with or without preanal pores; teeth compressed bearing two to three cusps; paired lamellae under digits.

Leposoma southi Ruthven and Gaige was described in 1924, the type locality being Progreso, Chiriquí Province, Panamá. Burt and Burt, in 1931, while reviewing the American Museum collections, placed *southi* in the synonymy of *Leposoma dispar* Peters (type locality, Cáceres, Colombia).

In 1949 I described a Costa Rican lizard from one-half mile W of El General (not San Isidro del General as suggested by Ruibal), Costa Rica, as *Leposoma bisecta.* The type locality is on the Pacific slope at an elevation of approximately 300 meters. The species obviously was not *Leposoma dispar.*

Ruibal (1952) resurrected *Leposoma southi* from the synonymy of *Leposoma dispar,* and synonymized *Leposoma bisecta* with *Leposoma southi* despite certain acknowledged differences, this without having seen any western Costa Rican specimens. Fortunately the collections from my 1952 Costa Rican expedition contain representatives of species of *L. bisecta* from the Pacific drainage; two of them from San Isidro del General are only a few kilometers from the type locality, El General. These are females and the constancy of male characters (*i. e.* femoral and preanal pores) cannot be obtained. Two other specimens from Palmar in the western lowlands are juvenile and do not lend themselves too well to comparison although the smallest, 16 mm. snout-to-vent length, taken from an egg, is a male with six femoral pores discernible.

Southi was described without reporting the presence or absence of femoral or preanal pores.

KEY TO FORMS OF LEPOSOMA IN COSTA RICA

Seven dorsal scalerows; gular scales smaller, more numerous; third chinshields single; scales round body in 26 rows; femoral pores 7-7.
Leposoma southi southi

Five dorsal scale rows; gular scales larger and fewer in number (two to four rows); third chinshield replaced by two scales, the two followed by three scales; scales around body in 19-21 rows; femoral pores, 4-4.
Leposoma southi orientalis

Leposoma southi southi Ruthven and Gaige

(Figs. 59, 60)

Leposoma southi Ruthven and Gaige, Occ. Papers Mus. Zool., Univ. Michigan, no. 147, April 26, 1924, p. 1-3 [type locality, Progreso (90 ft. elev.), Chiriquí Province, Panamá]; Ruibal, Bull. Mus. Comp. Zool., Harvard Col., vol. 106, no. 11, June 1952, pp. 482-485.

Leposoma dispar Burt and Burt, Bull. Amer. Mus. Nat. Hist., vol. 61, 1931, p. 347 (*part.*), and Trans. Acad. Sci. St. Louis, vol. 28, no. 1, June 1, 1933 (or Aug. 1, both dates given), p. 67 (*part.*).

Leposoma bisecta Taylor, Univ. Kansas Sci. Bull., vol. 33, pt. 1, no. 5, 1949, p. 275 (type locality, half mile west of El General, San José Province, Costa Rica).

I am following Ruibal in this arrangement somewhat reluctantly because I have not examined his material nor the type material of *southi*. He does not specifically identify the specimens from which his data was taken.

Diagnosis: Characterized by a large divided frontonasal narrowed anteriorly; head scales ridged or striate; dorsal, ventral, gular, and caudal scales strongly keeled; four supraoculars; prefrontals short, as wide as long; no postfrontal; frontoparietals present; interparietal usually larger than parietals; dorsal and lateral scales mucronate, somewhat leaf-shaped, the sides not parallel; ventrals strongly keeled, mucronate; one undivided postmental followed by three pairs of chinshields, the anterior two pairs in contact mesially; scales from eye to shoulder, rough, often pyramidal or conical. Femoral pores in males only; preanal pores in males and usually also in females; paired lamellae under digits.

Description (From type of *Leposoma bisecta* Taylor): Rostral slightly more than twice as wide as high; frontonasal divided into two elongate scales, narrowing anteriorly; a pair of prefrontals nearly as broad as long, in contact with each other for a little more than half their length (due to an injury one is partially fused to frontal); frontal concave laterally, broadly angular anteriorly and posteriorly, one and one-third times as long as wide; frontoparietals pentagonal, in contact with each other for half their length; interparietal larger than the parietals and separating them. Scales following the parietals and interparietal not or but little differentiated from other neck scales; four supraoculars. All dorsal head scales with either two, three, or four heavy ridges or keels.

Nostril pierced in a large nasal, the scale having a slight groove above nostril suggesting a suture; five scales in combined subocular-preocular series, including "loreal"; four supraciliaries; two or three small postoculars not distinguished from other temporal scales; lower eyelid with a transparent area divided into two parts; seven upper labials in the following ascending order of size: 6,1,5,4,3,2,7; five lower labials; a large azygous postmental followed by two pairs of chinshields which are in contact mesially and border the labials either entirely or partially (second pair); a third pair much smaller, separated from the labials by two or three scales, and from each other by a slender elongate scale; each of the third pair followed by three scales, these separated by two or three smaller scales. There follows a row of very small keeled scales that extends

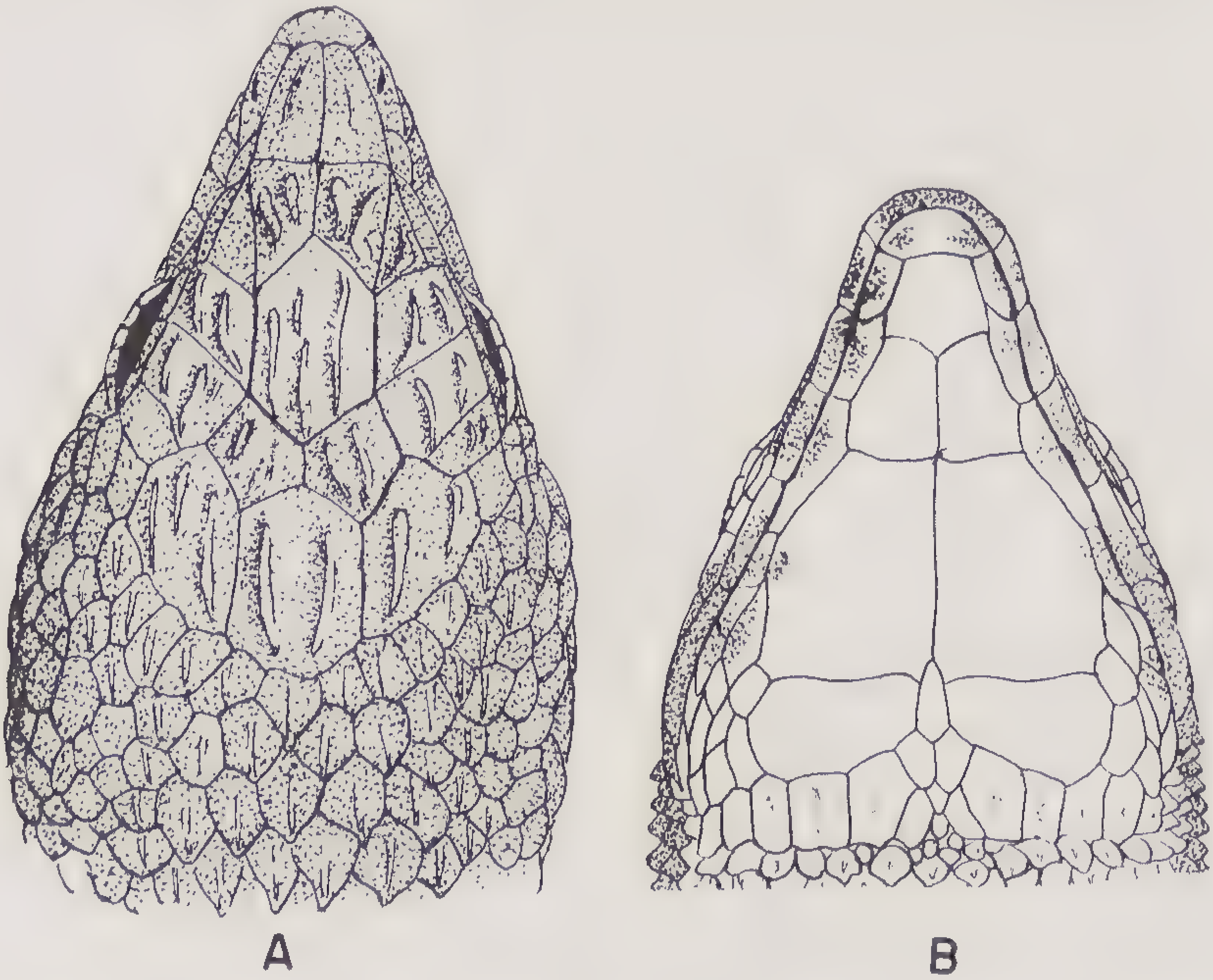

FIG. 59. *Leposoma southi southi* Ruthven and Gaige. KUMNH No. 23801, type of *Leposoma bisecta* Taylor. El General, Costa Rica. A. Head dorsal view; B. Head ventral view. Actual head width, 67 mm. (slightly diagrammatic).

to the very large auricular opening. Seven rows of temporal scales; postauricular scales pyramidal or subconical. No trace of a gular collar or fold.

Scales of dorsum large, imbricate, heavily keeled, each terminating posteriorly in a small spine, forming somewhat irregular transverse series and regular oblique series; 26 scales in row about middle of body; 32 scales from occiput to posterior level of thighs; 35 rows from chinshields to preanal pore-scales; four contiguous preanal pore-scales immediately preceding preanal scales. Scales of breast and abdomen arranged in regular transverse series in six longitudinal rows, all strongly keeled, the keels terminating in spines posteriorly. These scales differ from the gular series in having their sides more nearly parallel. Five preanal scales border the vent, arranged as follows: a small median scale preceded by a larger triangular scale and these two bordered laterally by two elongate widened scales narrowed at each end; outermost scales small. Femoral pores 7-7; four preanal pores arranged 2-2.

Limbs pentadactyl, all clawed; inner finger and toe reduced; scales on upper surfaces of arm more or less regular, keeled; those on under surface smaller, some tetrahedral with keels reduced; scales about arm insertion small, more or less tubercular; scales on front and dorsal surface of legs irregular in size, more or less similar in shape; scales on posterior part of thigh granular with a patch of slightly larger scales; scales smaller in groin and about leg insertion; scales under digits in two rows.

Tail (regenerated for the most part) somewhat compressed, bearing a more or less distinct lateral groove; scales on regenerated part of tail similar to those of original tail.

Auricular opening very large, nearly equal to eye-opening.

Tongue covered with scales or plicae (not papillae).

Color: Dark indefinite brown, the scales with minute black flecks or punctations; a light tan dorsolateral line from middle of neck to some distance on tail, distinct anteriorly, less distinct in middle of body, forming a series of light dots on tail; sides of neck and body darker; head blackish on top and sides; venter light, immaculate save for a few flecks under tail; regenerated part of tail darker above and below; white spots on upper and lower labials alternate with similar dark areas; a few cream spots on side of neck. Scales or lamellae under feet and toes blackish.

Measurements (in mm.): Snout to vent, 34.5; snout to arm, 13.2; axilla to groin, 17.3; tail (regenerated), 43; arm, 10.2; leg, 13; head width, 6.7; head to auricular opening, 8; head length, 10.

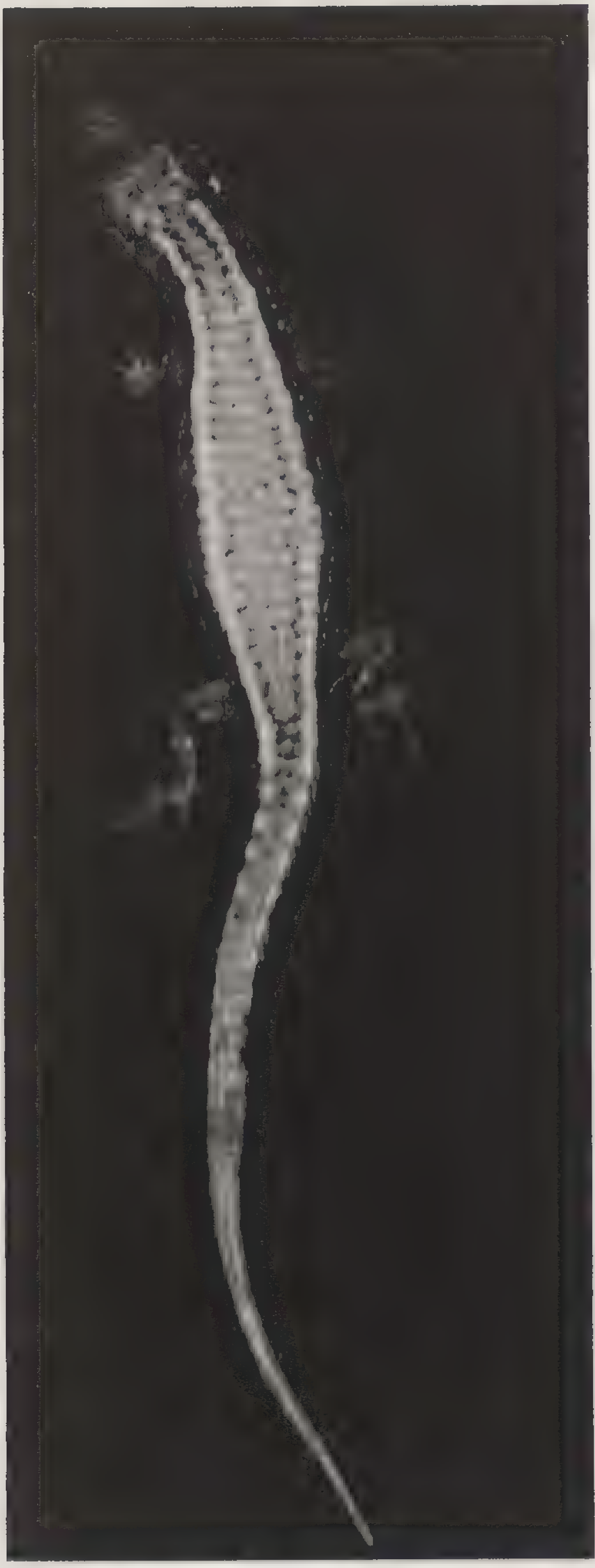

FIG. 60. *Leposoma southi southi* Ruthven and Gaige. RCT No. 974a, El General (near San Isidro del General), San José Province, C. R.; actual length, 86 mm.; topotype of *Leposoma bisecta* Taylor.

Variation: The type and paratypes of *Leposoma southi* Ruthven and Gaige may all have been females as they fail to mention the presence of femoral pores. However, preanal pores usually present in females are not mentioned either. Ruibal (1952), who recognizes the species *Leposoma southi* reports that the species has 4-4 femoral pores and 2-2 preanal pores. Whether these data are based on the type material (topotypic or paratypic) or on specimens from Suretka, Costa Rica, Barro Colorado Island, Canal Zone, and El Valley, Coclo Province, Panamá that were available to Ruibal, I cannot say.

The presence of seven femoral pores in the type, and six pores in a specimen from Palmar suggest that *bisecta* Taylor is a different form from *southi*. Another difference that likewise seems to have significance is the presence of a light tan or cream dorsolateral line extending from head to some distance on the tail. This is not mentioned as a character of *southi* but, of course, it might have been overlooked by the original describers, as well as by Ruibal. Ruthven and Gaige mention a dorsal band of reddish brown from occiput to tail, becoming lighter on the sides; while the head and tail are deep brown, almost black.

The number of scales around body as reported by Taylor is greater than that reported by Ruibal but the wide range, 20-25, suggests that the lower count is based on Suretka specimens that likewise differ from *southi* (*sensu* Ruthven and Gaige) in other characters (see Burt and Burt, 1933 and Ruthven and Gaige 1924).

The table of measurements and data show the general characteristics of the six specimens, two males and four females, available to me. The normal number of subcaudals seems to be 65 to 67—the latter count being from a very young specimen, 16 mm. snout-to-vent measurement. The transparent eye-area is divided into two larger parts in all specimens. The dorsolateral stripe is present in all. It is distinct in the smallest specimen and only slightly obscured in the type near the middle of the body.

No. 34184 is from an egg found at the base of a tree. It was probably on the point of hatching. An embryo from one egg escaped when the egg was broken. In the unhatched young the hemipenes are completely extruded. The ventral coloration in life of Nos. 34181 and 34182 San Isidro del General, Cartago Province, was "dull yellow-flesh." Nos. 34183 and 34184 from Palmar, Puntarenas Province had white chins and pink coloration in the anal region. Another specimen captured was distinctly reddish on the posterior part of the body and the tail base. The eggs are leathery, slightly longer than wide. The female (without a number) contains two eggs, one in each oviduct. Two eggs probably represent the typical clutch.

Measurements and scale data on Leposoma southi southi

Number	Sex	Snout–vent	Snout–arm	Tail	Arm	Leg	Axilla–groin
Type.........	♂	34.5	13.2	43*	10.2	13	17.3
974a**........	♀	39	14.5	47*	12	14	19.4
34181.........	♀	34.8	14	54.4*	8.2	12.4	18
34182.........	♀	32.2	13	44.8*	8.4	12	17.8
34183.........	♀	20	8.8	....	6	7.7	9
34184.........	♂	16	....	....	....	....	....

Number	Supralabials	Infralabials	Scales around body	Sub-caudals	Preanal pores	Femoral pores
Type.............	7–7	5–5	26	....	2–2	7–7
974a.............	7–7	5–5	22	....	1–1	0–0
34181............	7–7	6–6	24	65	1–1	0–0
34182	7–7	5–4	24	....	0–0	0–0
34183............	8–7	5–4	24	....	1–1	0–0
34184............	....	....	24	67	2–2	6–6

* Regenerated.
** 974a RCT collection.

Leposoma southi orientalis * Taylor

Leposoma southi orientalis Taylor, Univ. Kansas Sci. Bull., vol. 37, pt. 1, Oct. 15, 1955, p. 546 (type locality, Volio, Limón Province, C. R.).

Leposoma southi Ruthven and Gaige (*part.*), Occ. Papers Mus. Zool. Univ. Michigan, no. 147, 1924, p. 1-3 (a specimen in the collection of the Museum of Comparative Zoology, Harvard College, from Suretka, on the Sixaola River, Costa Rica, that "corresponds fairly well with *L. southi* with the exception of the chin shields").

Leposoma dispar Burt and Burt (*part.*), Bull. Amer. Mus. Nat. Hist., vol. 61, art. 7, pp. 347-349 (two specimens M. C. Z. Nos. 18916-17).

Leposoma southi Ruibal (*part.*), Bull. Mus. Comp. Zool. Harvard Coll., vol. 106, no. 11, June 1952, pp. 484-485 (at least Suretka specimens M. C. Z. Nos. 18916-17).

Diagnosis: A small subspecies, maximum known snout-to-vent length, 36.5; preanal pores, 2-2, femoral pores, 4-4. Differs from *Leposoma southi southi* in having gular scales larger, in fewer (two to four) rows; two pairs of chinshields, both in contact; third chinshield of *southi* replaced by two scales of equal (or unequal) size and the two followed by three somewhat enlarged scales; body more slender with five rather than seven rows of dorsal scale rows. Scales around body, 19 to 21; transverse rows on venter from breast to preanal scales, 18-20; transverse dorsal scalerows from occiput to back level of thighs, 29-30; eye smaller and ear larger; transparent eye area divided into four or five scales rather than two; dorsolateral stripe moderately distinct.

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* From Latin *orientalis* = eastern.

Description (From type specimen KUMNH No. 36124 ♂. Volio, Limón Province, C. R.): Rostral two and one-third times as high as wide; a pair of internasals longer than wide bearing two narrow rounded ridges or keels that meet anteriorly; a pair of prefrontals broadly in contact mesially, likewise with two keels, and two or three tiny rounded tubercles; one scale partially fused with the frontal; latter longer than wide with a pair of lateral keels and several rounded or elongate tubercles; frontoparietals broadly in contact each with three elongate tubercles or keels and two or three tubercles. Parietals large, about as long as wide, with one elongate keel and one short keel; interparietal between parietals with two lateral keels; four supraoculars, three touching frontal, each with two keels, except first with one; four supraciliaries the first large, three times size of second; upper eyelid narrow probably not movable; nostril in posterior part of single nasal; first loreal, larger and higher than second; second much higher than wide; a small preocular followed by four suboculars; five postoculars; six supralabials the last much enlarged. Opaque part of eyelid with four (or three) scales.

Mental with a longer labial border than the rostral, its width less than twice its length; a large azygos postmental; second paired, the common suture less than greatest length of scale; third pair very large forming a long mesial suture and laterally in contact with two infralabials, each bordered behind by four or five somewhat keeled scales and a small median smooth scale; these bordered behind by twelve keeled scales nearly as large as preceding; five infralabials narrow, smooth. Ear-opening very large nearly equalling eye. Back and sides covered with large keeled more or less mucronate scales, those in the middle part of dorsum largest, not forming lines, and somewhat irregular in size; the ventral scales are keeled, mucronate and as large as dorsals, the keels forming continuous lines; twenty scalerows about middle of body, the laterals smallest; about four and one-half rows on back in the light dorsal area; about 29 transverse rows from parietal to vent; about the same member on venter between last postmentals and the preanal scales; anal flap covered by six scales: two mesial, one behind the other; these bordered laterally by an elongate scale and this bordered by one considerably smaller on the outer side; four femoral pores; four preanal pores the two median each partly surrounded by a large scale. Scales in the preauricular region rather small keeled or not; postauricular area covered with rough moundlike pyramidal or keeled scales, irregular in size, smaller than the dorsal nuchal scales.

Arms and legs covered with keeled imbricate scales above and below; digits rather short with small flat paired lamellae or scales, 11 under longest finger, 15 under longest toe.

Caudal scales keeled, slightly mucronate smaller and more regular than dorsal scales; the keels high tending to form a continuous keeled line separated by a deep trough from the adjoining one.

Color: Head dark brownish-black, each of the lighter labials with a dark spot except the sixth which is uniformly dark. The dorsal surface brownish tan with some scattered pigment, except on the anterior part of the dorsolateral scalerow, which may lack pigment entirely. The side more heavily pigmented forming a dark stripe from neck to tail. On the ventral surface the chin cream white. The venter and base of tail somewhat pinkish.

Measurements and scale data on type and paratype: Nos. 36124 ♂, 36125 ♀; snout to vent, 36, 36.5; snout to arm insertion, 13.8, 13; tail, 41,* 61; total length, 77, 97.5; arm, 11.8, 9.5; leg, 13, 13.2; axilla to groin, 18, 18.2; supralabials, 6-6, 6-6; infralabials, 5-5; scales around body, 19-20, 19-20; occiput to back level of thigh, 31, 30; subcaudals, —, 66; scales on eye disc, 4-4, 3-4; femoral pores, 4-4, 0-0; preanal pores, 2-2, 1-1.

Genus ANADIA Gray

Anadia Gray, Catalogue of the lizards in the collection of the British Museum, 1845, p. 74 (type of the genus, *Anadia ocellata* Gray); Taylor, Univ. Kansas Sci. Bull., vol. 37, pt. 1, 1955, pp. 534-545, figs. 12, 13.

Description of genus: Slender, elongate lizards, the head narrowed and rather pointed. Head with regular shields; frontonasal present separating nasals; nostril in a single nasal, or in a suture between two nasals; eyelids developed, with a divided transparent area on lower lid; scales smooth, juxtaposed, or slightly imbricate, forming transverse rows; ventrals equal to or a little larger than dorsal, quadrangular, forming transverse and longitudinal series. Tail cylindrical; lateral teeth compressed, tricuspid; tongue bifid, somewhat arrow-shaped; auricular opening present; limbs rather weak, pentadactyle. At least some forms arboreal.

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* Incomplete.

This genus comprises some nine or ten species distributed chiefly in northern South America. Only a single species is known in Central America. This was described in 1875 by E. D. Cope as *Chalcidolepis metallicus* from a single specimen collected by William Gabb in the Aguacate Mountains of Costa Rica. Later Cope (1885) placed his *Chalcidolepis metallicus* in the genus *Leposoma.*

KEY TO FORMS OF ANADIA IN COSTA RICA

1. Femoral pores, 3-?; 23 scales about body; 56 transverse dorsal rows between parietal and back level of thigh; brown above, a row of blackish marks on each side .... *metallica metallica*
   Femoral pores 5 or more; more than 25 scales round body 2
2. Femoral pores, 5-5; 28 scales about body; 63 transverse scalerows between parietals and back level of thighs; back strongly spotted with black .... *metallica arborea.*
   Femoral pores, 9-10; 28-31 scales about body; 52-56 scales between parietals and back level of thighs; black spotting on back reduced or absent .... *A. metallica attenuata*

The material is inadequate to determine positively whether we are dealing with species or subspecies. One may presume that *metallica* occupies the Pacific drainage of the Aguacate mountains and perhaps also of the adjoining Talamanca Range; *arborea* the Pacific slopes of the Cordillera Volcanica; and *attenuata* the Caribbean drainage of the Meseta Central and the eastern slope of the Talamanca Range. It may be doubted that the barriers are such as to bring about complete isolation. An accumulation of a series of specimens from a given locality will permit one to determine the extent of variation and to make a clearer interpretation of the specific or subspecific relationship.

Anadia metallica metallica Cope

(Fig. 16, *Chalcidolepis metallicus*)

Chalcidolepis metallicus Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1876 (1875), pp. 116-117, pl. 24, fig. 5; pl. 28, fig. 2 (type locality, "Aguacate Mountains," Costa Rica, William Gabb, coll.).

Ecpleopus (*Chalcidolepis*) *metallicus* Bocourt, Mission Scientifique au Mexique et dans l'Amérique Centrale; Étude sur les Reptiles, livr. 6, 1879, pp. 371-372.

Leposoma metallicum Cope, Proc. Amer. Philos. Soc., vol. 23, no. 121, Jan. 1886, pp. 97-98; U. S. Nat. Mus. Bull. no. 32, 1887, p. 45.

Anadia metallica Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Aug. 1885, p. 30; Boulenger, Catalogue of the lizards in the British Museum, 2nd ed., vol. 2, p. 400; Loveridge, Proc. Biol. Soc. Washington, vol. 42, Mar. 25, 1929, pp. 99-102 (*part.*).

Anadia metallica metallica Taylor, Univ. Kansas Sci. Bull., vol. 37, pt. 1, Oct. 15, 1955, pp. 535-537.

Diagnosis: A slender lizard with a tail nearly twice length of head and body; greatest known snout-to-vent length, 58 mm.; head narrowed, pointed; limbs with five digits, all clawed; 23 scales subequal in size in a transverse row around body; frontonasal single, separating nasals; 55 scales from parietals to level of posterior face of femur; two large preanal scales preceded by a somewhat smaller pair; occipitals enlarged. Teeth compressed with a central cusp flanked by a denticle on each side; 3-? femoral pores.

Description of species (Data from Cope's type description): A slender lizard with a very long tail and feeble limbs; head narrowed and acute in front, with a produced rostral shield; frontonasal as wide as long; frontal elongate, two prefrontals, two frontoparietals, two parietals separated by an interparietal; four supraoculars; interparietal elongate having parallel sutures with the larger parietals; latter bounded externally by a large temporal, forming with them a diagonal suture; these all are bounded posteriorly by a series of four shields across the occiput, and these in turn by a transverse series of seven scales larger than those on the nape following them; nasal followed by a large loreal and this by a smaller preocular; seven supralabials, 4,3,1,2,6,7,5, being their diminishing order of size; two pairs of chinshields are in contact in median gular region, the posterior pair being twice as long as the first. Nostril in a single nasal plate; tympanum distinct.

Dorsal scales all smooth in uninterrupted transverse annuli round the body, the size subequal on the various regions including the nuchal and gular; twenty scales in a crossrow between the angles of the lower jaw; scales in pectoral region irregular, the last row of the neck having the appearance of a collar; 23 series of scales in an annulus of the body; twelve transverse rows between large longitudinal anal scales, which embrace a scale between them on the anal border; these preceded by another large pair, but of reduced size.

Toes 5-5, all clawed. Tail nearly twice head-body length; hind limb one fourth head-body length. Limbs surrounded by large scales except on concealed faces of humerus and femur, where the scales are small and flat; lower eyelid dried so its characters are obscured.

Color: Light gray with red and green metallic reflections; sides brown, the middle of back darker than a line above the brown of the side near the light dorsolateral lines; a few scales are blackish, forming a row on each side; venter dusted with brown; head with deep brown sides and a white upper lip; sides of tail with brown stripe having a zigzag upper margin.

Measurements in mm.: Total length, 165; head-body length, 58; tip of snout to axilla, 17; length of head to tympanum, 11; length of head to orbit, 4.5; length of arm, 13; length of leg, 14.5.

Remarks: Dr. Doris Cochran has kindly re-examined the type. She writes: "The type of *Chalcidolepis metallicus*, USNM 30568, is not in the best shape, being pretty dry, and having lost its left leg. Its right leg shows 3 femoral pores, the 3rd quite faint. Perhaps there are only 21 or 22 scales around the body—it is too brittle to say exactly. The nasal and first labial are broadly in contact. The first pair of chinshields are as long as the mental; the second pair is a little longer than the first; the third pair is shorter than either pair, 1 or pair 2, and are separated by a small scale, while the first two are entirely in contact."

Anadia metallica arborea Taylor

(Fig. 61)

Anadia metallica arborea Taylor, Univ. Kansas Sci. Bull., vol. 37, pt. 1, 1955, pp. 542-545, fig. 13 (type locality, Los Flores, Tenorio, Las Cañas, Guanacaste Province, Costa Rica).

Diagnosis: A slender, elongate species, the male with 5-5 femoral pores; 63 transverse dorsal scale series between parietal and back level of thigh; back heavily spotted with black, the spots covering from two to four scales; 28 scales in a row about middle of body.

Description of type: Body elongate, slender, the tail twice head-body length; head slender, the snout narrowed, rounded at tip; rostral large, in contact posteriorly with two labials, and the frontonasal, the suture with the latter curving; the length of part visible from above about half length of frontonasal; latter single, seven-sided, forming a considerable suture with first labial anterior to the nasal; prefrontals rather large, nearly half the area of frontonasal, laterally touching nasal, loreal, and the diminutive first supraocular; frontal relatively small, larger than the prefrontals, smaller but equally as long as the frontonasal; frontoparietals small touching frontal, two supraoculars, interparietal, and parietals; latter scales relatively very large, terminating posteriorly in an acute angle, separated by a parallel-sided interparietal; the parietals touch last supraocular, upper postocular, and two temporals, the upper of which is much enlarged; interparietal touches three enlarged postparietal scales; transverse series of scales following the postparietals likewise modified, larger than the nuchal series which follow behind.

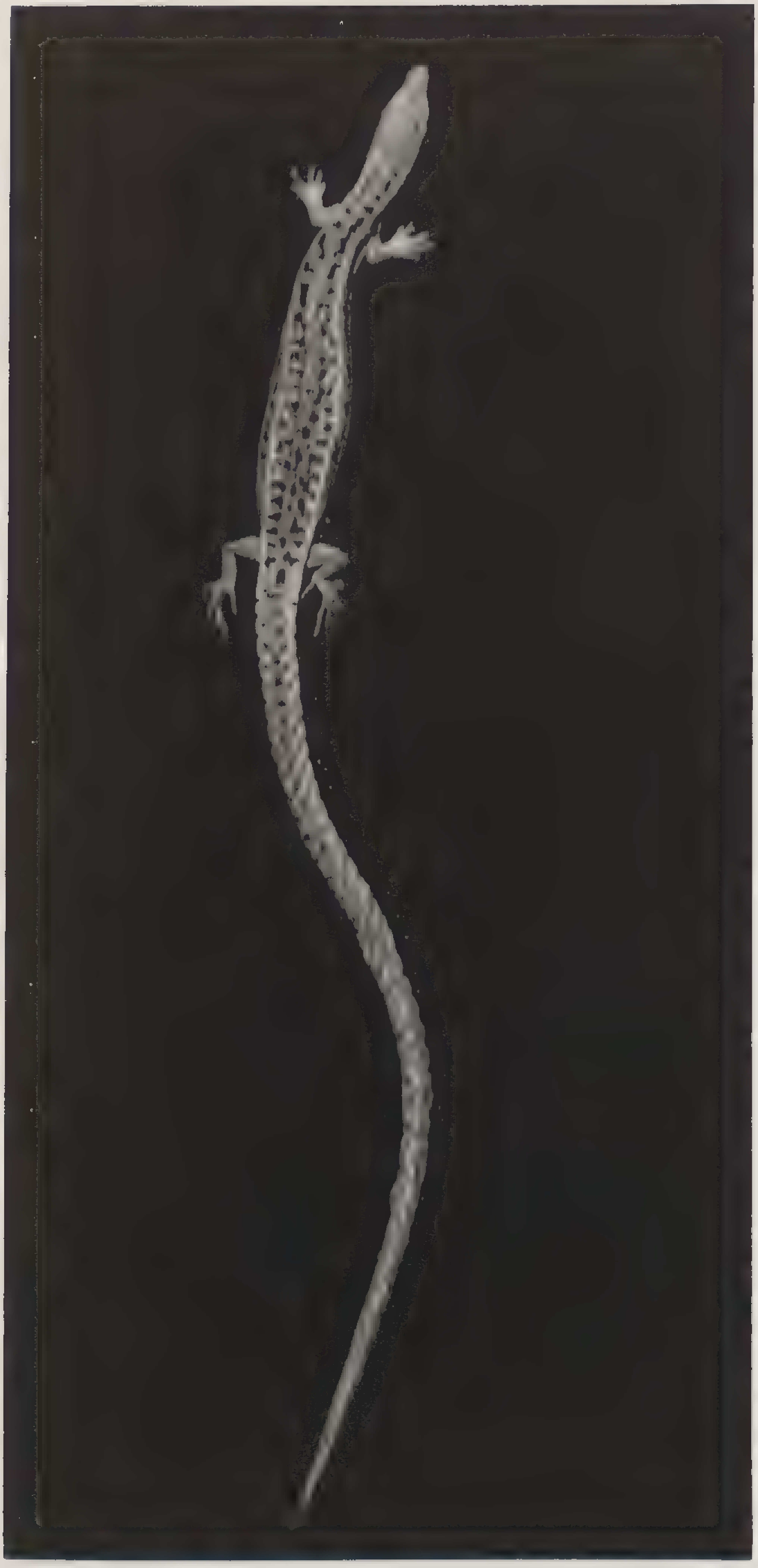

FIG. 61. *Anadia metallica arborea* Taylor. KUMNH No. 34225, type; Las Flores, Tenorio, Las Cañas, Guanacaste, C. R.; actual length, 181 mm.

Nostril in a single nasal, separated from rostral by a distance more than a third of its length, its size less than that of loreal which borders it behind a small preocular; nostril above latter half of the first labial; four supraoculars, first very small, the series bordered laterally by five supraciliaries, a smaller second loreal (frenocular) and three small suboculars; four larger postoculars; about four series of temporals, showing much variation in size; an enlarged scale borders the auricular opening; lower eyelid well developed, with a longitudinal series of transparent scales; auricular opening nearly circular, much smaller than eye-opening.

Seven supralabials, 1, 4, 3, 6, 2, 7, 5 being the diminishing order of size; five infralabials, the last nearly concealed under the supralabial but bearing a brown spot; the following scale is small but likewise might be counted as the sixth infralabial lying as it does below or under the seventh supralabial; labial border of mental equal that of the rostral; azygos postmental large; three pairs of chinshields, the first two broadly in contact, the third pair narrowly separated, narrowed almost to a point on their inner border; the second pair longer than first; three small scales lie between the posterior parts of the third pair; these followed by the first transverse gular row consisting of nine scales, the two outer greatly enlarged and touching fourth infralabial, separated by one scale from the fifth infralabial; seventeen complete and two incomplete rows of gulars between third chinshields and (including) scales forming the nuchal collar; three enlarged modified pectoral scales following the nuchal collar; 37 transverse scalerows from nuchal collar to the last transverse row on abdomen; these scales square or rectangular save those on breast and those in last row; the preanal series consists of a small triangular median scale bordered laterally by two large scales that make a common suture anterior to the median scale, then are separated anteriorly by another scale; these bordered laterally by a narrow elongate lateral scale and these in turn by a very small narrow scale; anterior to these is a second series of four scales.

Femoral pores 5-5, the innermost situated so that it might be regarded a preanal pore but it is practically continuous with the femoral series; following vent there are two or three irregular granular series of scales; first two annuli of caudals small, the total subcaudal series being 108; 62 transverse rows from interparietal to back level of thigh; scales on side of neck, about ear, postaxillary region, and about leg insertion, smaller and somewhat irregular; scales in a row about middle of body 28. There is a tendency for the smaller axillary scales to be continued posteriorly on side for some distance. Occasionally the annuli are broken on back and they tend to alternate.

Limbs slender, pentadactyle, digits all clawed; scales under palms and soles, as well as on basal portion of digits, flattened, padlike; the two terminal joints of digits compressed, the lamella forming a median ridge or angle; digits more or less angular; all with strong claws; arm with large scales except on underside of upper arm; leg with large scales save on posterior part of thigh and on part of ventral surface of thigh.

Color in life: Generally light brownish-olive above, the head mottled with olive; a clay-colored dorsolateral line beginning on the head passes over eyes, along neck and side of body; dorsum brownish olive above with two irregular series of black spots from occiput to tail, even continued some distance on tail but growing more indefinite on latter half; some scattered dots between the rows; a dark-edged brown stripe beginning on snout passes along side of head, becoming less distinct on side of body and tail; on this are a few small white flecks with darker borders, especially in axillary region, and an indefinite row of dark spots; a cream-white line from tip of snout covers the labials and extends back, becoming continuous with the white or cream color of the chin and venter; on belly the scales have a faint scattering of brownish pigment; chin and throat pure white. Some black spots continued onto tail; the clay-colored dorsolateral stripe interdigitates with the lateral brown stripe on basal part of tail but it gradually merges into the more uniform brownish color; a row of somewhat quadrangular light spots along ventrolateral part of tail; limbs tan with numerous, more or less distinct small brownish spots.

Measurements in mm. and scale data of type, KUMNH No. 34225: Sex, ♂, snout to vent, 63; snout to arm insertion, 20; axilla to groin, 39; tail, 118; total length, 181; arm, 12; leg, 15; femoral pores, 5-5; scales around body, 28; scales from parietals to back level of thigh, 63; scalerows from chinshields to front subcaudals, 108; scales from nuchal collar to front level of thigh, 37.

Remarks: This specimen was discovered on a tree bole some eight feet from the ground by John Baker. Despite its short, rather weak limbs it ran with dexterity. I finally managed to capture the specimen by driving it down with a long pole until it was within reach. No other specimens were seen. I presume that this is also an arboreal species.

Anadia metallica attenuata Taylor

(Fig. 62)

Anadia metallica attenuata Taylor, Univ. Kansas Sci. Bull., vol. 37, 1955, pp. 537-542, fig. 12, (type locality, Pacuare, Río Pacuare, on road between Turrialba and Moravia de Chirripó, Cartago Province, Costa Rica).

Diagnosis: Frontonasals separated from the first labial or not; rows of black dots on dorsal surface reduced or absent; dorsolateral light line extending to tail, then breaking up into two series of small, clay-white spots; a series of small, white or cream dots on sides from axilla to groin, those near axilla with dark borders; 9-10 femoral pores; 28-31 scalerows around middle of body; 14 rows of gular scales between chinshields and nuchal collar; scales from parietals to back level of thigh, 53-56.

Description (From type specimen): Body slender, the basal region of the tail plumper and nearly as wide as body for some distance; rostral large, the part visible above about half length of frontonasal; latter longer than wide, separated from the first labial by the nasal; prefrontals rather large, each nearly half the area of the frontonasal, touching nasal, loreal, and first supraocular laterally; frontal widened anteriorly, narrowed posteriorly, about as long as frontonasal; four supraoculars, first small, three touching frontal; a pair of small frontoparietals, each touching frontal, two supraoculars, parietal and an interparietal; interparietal shaped somewhat like frontal, the widened part posterior, the sides definitely not parallel; parietals large, their posterior part forming less than a right angle; each touching last supraocular, upper postocular, and three other large scales; the parietal series bordered behind by a row of specialized postparietals; some of the scales of the temporal area enlarged, one of which borders the auricular opening; nasal single; nostril above middle of first labial; a large loreal, nearly as high as long; five supraciliary scales; four postoculars; supralabials 7-7, the fourth largest, the fifth smallest; auricular opening less than half length of eye; 6-6 infralabials, the last small; mental about size of rostral; a large azygos postmental; three pairs of chinshields, the last pair largest, forming a short median suture anteriorly, separated posteriorly by two scales; first transverse gular row consisting of eight scales, the outer relatively very large, separated from sixth infralabial by one narrow scale; 15 rows of gular scales including "collar" series; lateral scales narrower than dorsals or ventrals; small scales present about limb insertions; all scales smooth, the dorsals quadrangular, somewhat imbricating; large scales on limbs, except on underside of upper arm and the ventral and posterior part of

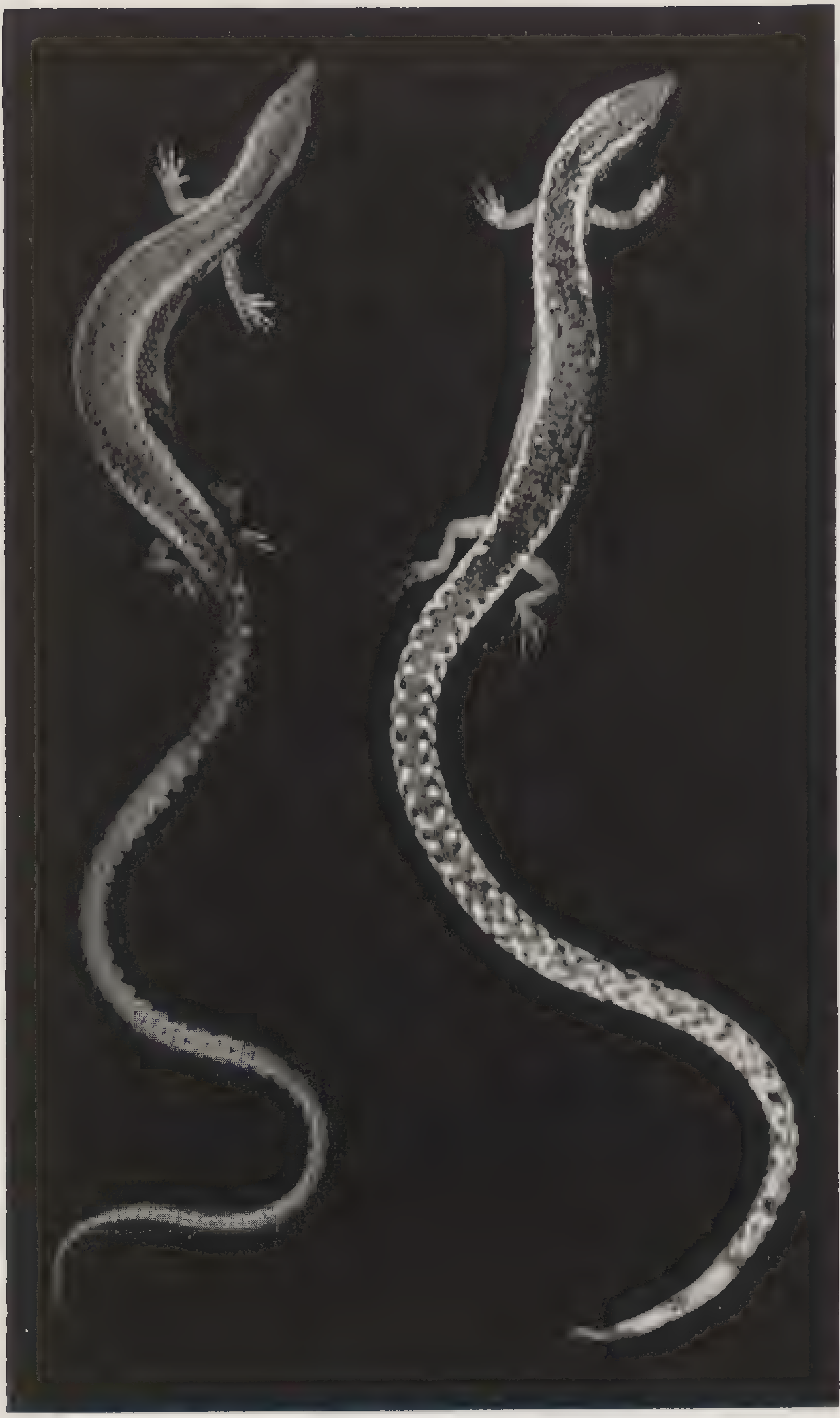

FIG. 62. *Anadia metallica attenuata* subsp. nov. Type and paratype. Left figure, KUMNH No. 34224, paratype; Moravia de Chirripó; right figure, KUMNH No. 34223, type; Pacuare, Río Pacuare, on road between Turrialba and Moravia de Chirripó; actual length, 177.

thigh; soles, palms, and basal joints of digits with padlike scales; only one, or sometimes two, divided on each toe; on two terminal joints of each digit the lamellae compressed; a strong terminal claw.

Scales in a row about middle of body, 31; dorsal scales from parietals to back level of thigh, 52; scales from posterior chinshields to front level of thigh, 50; subcaudals (tip of tail regenerated), 95; six preanal scales, the four median longest; second row with four scales.

Color in life: Dorsum somewhat mottled olive; head lighter with a very indefinite pattern; a pair of dirty-white or clay dorsolateral lines extending from anterior supraoculars to tail where they tend to break up on each side into two more or less regular series of cream-colored spots, but becoming more irregular towards tip of tail; a pair of short light lines in nuchal region; a brown stripe with darker edges begins behind eye, continues on neck and side of body to tail, growing lighter and more indefinite posteriorly; a few ocelli in axillary region continuing as a series of indefinite light dots to groin; limbs variegated cream-white and light brown; chin, throat, breast, and underside of arms almost pure white; venter dirty white with a very fine sprinkling of gray pigment usually concentrated into indefinite areas on each scale; underside of tail with a light salmon wash and with some fine scattered brownish pigment.

Measurements in mm.: Snout to vent, 58.5; snout to arm insertion, 18.7; axilla to groin, 33.5; tail, 119 (tip regenerated); total length, 177; arm, 12; leg, 15.5.

Remarks: The type locality is only a few kilometers from Moravia de Chirripó, where another specimen was obtained in a tree. The type specimen was captured in a field recently cleared of forest trees. The rather heavy claws suggest that the species is arboreal rather than terrestrial. Variation in the species is discussed by Taylor (*loc. cit.* 1955).

Genus PTYCHOGLOSSUS Boulenger

Ptychoglossus Boulenger, Proc. Zool. Soc. London, 1890, p. 83, pl. 2, fig. 2 [type of genus *Ptychoglossus bilineatus* Boulenger = *P. pictipes* (Cope)].

Diastemalepis Peracca, Bol. Mus. Zool. Univ. Torino, vol. 11, no. 235, 1896, pp. 1-2 (type of genus *Diastemalepis festae* Peracca); Boulenger, Zool. Rec. for 1896, no. 33, 1897, p. 22, places *Diastemalepis* as a synonym of *Ptychoglossus*.

This South American genus of five species is distributed from Ecuador north to Venezuela and Colombia, extending into Central America as far north as Costa Rica where only a single species is known.

Description of genus: "Tongue moderately elongate, arrowheaded, with oblique plicae converging toward the median line. Lateral teeth compressed, bicuspid or tricuspid. Head with large regular shields; frontonasal separating the nasals; praefrontals and frontoparietals present; nasal pierced in the suture between two nasals. Eyelids developed, lower scaly. Ear exposed. Limbs well developed, pentadactyl. Dorsal and lateral scales subequal, narrow with parallel sides, ending in an obtuse point, imbricate and keeled; ventral plates large, square, subimbricate, smooth, forming regular longitudinal and transverse series. A strong nuchal fold. Tail subcylindrical. Male with femoral pores." Boulenger.

Ptychoglossus plicatus (Taylor)

(Figs. 63, 64)

Alopoglossus plicatus Taylor, Univ. Kansas Sci. Bull., vol. 33, pt. 1, no. 5, Apr. 20, 1949, pp. 272-275, fig. 1 (type locality Morehouse (*nec* Morehead) Finca, 5 mi. SW Turrialba, Cartago Province, Costa Rica).

Ptychoglossus plicatus Ruibal, Bull. Mus. Comp. Zool. Harvard Col., vol. 106, no. 11, June 1952, pp. 479, 501 "Taylor's *plicatus* superficially approaches *Alopoglossus* more than any other species of *Ptychoglossus*. It is not, however, an annectant form."

Diagnosis: Dorsal scales around body forming nearly regular transverse and oblique keeled series; 30 scales from occiput to base of tail; 24 scales from chinshields to anals; 33-35 scales around body at middle, all strongly keeled save on belly; keels terminating in spines, the spine reduced or absent on lateral rows; ventrals in four regular longitudinal smooth quadrangular rows, outer larger than inner; gular collar indicated; four supraoculars; venter cream with dark spots or flecks in males (females may be white below).

Description of the type: Rostral nearly twice as wide as high forming a straight (or very slightly curved) suture with the frontonasal; latter large, in contact laterally only with nasal; prefrontals pentagonal, touching only preocular and first supraocular laterally; frontal wider near anterior end than at posterior end, sides slightly concave, ends broadly angular, in contact with three supraoculars; two frontoparietals, larger than prefrontals but at least one-fourth smaller than frontal; parietals large, longer than wide, much larger than other head scales, angular at anterior end, somewhat rounded posteriorly, and separated from each other by a large parallel-sided interparietal.

Nasal large, triangular, at least partially divided by a suture running up from nostril; a rectangular preocular much higher than wide; four supraoculars, four supraciliaries, anterior largest; two rows of ciliaries on upper eyelid; lower eyelid with a more or less transparent area divided into three parts; two presuboculars precede an elongate curved subocular; three presuboculars, the upper touching the anterior supraciliary; a small "loreal."

Seven upper labials, third greatly elongated, lying for the most part below eye; mental deeper and wider than rostral; six lower labials; large azygous postmental followed by three pairs of chinshields, first and second pairs in contact mesially and in contact

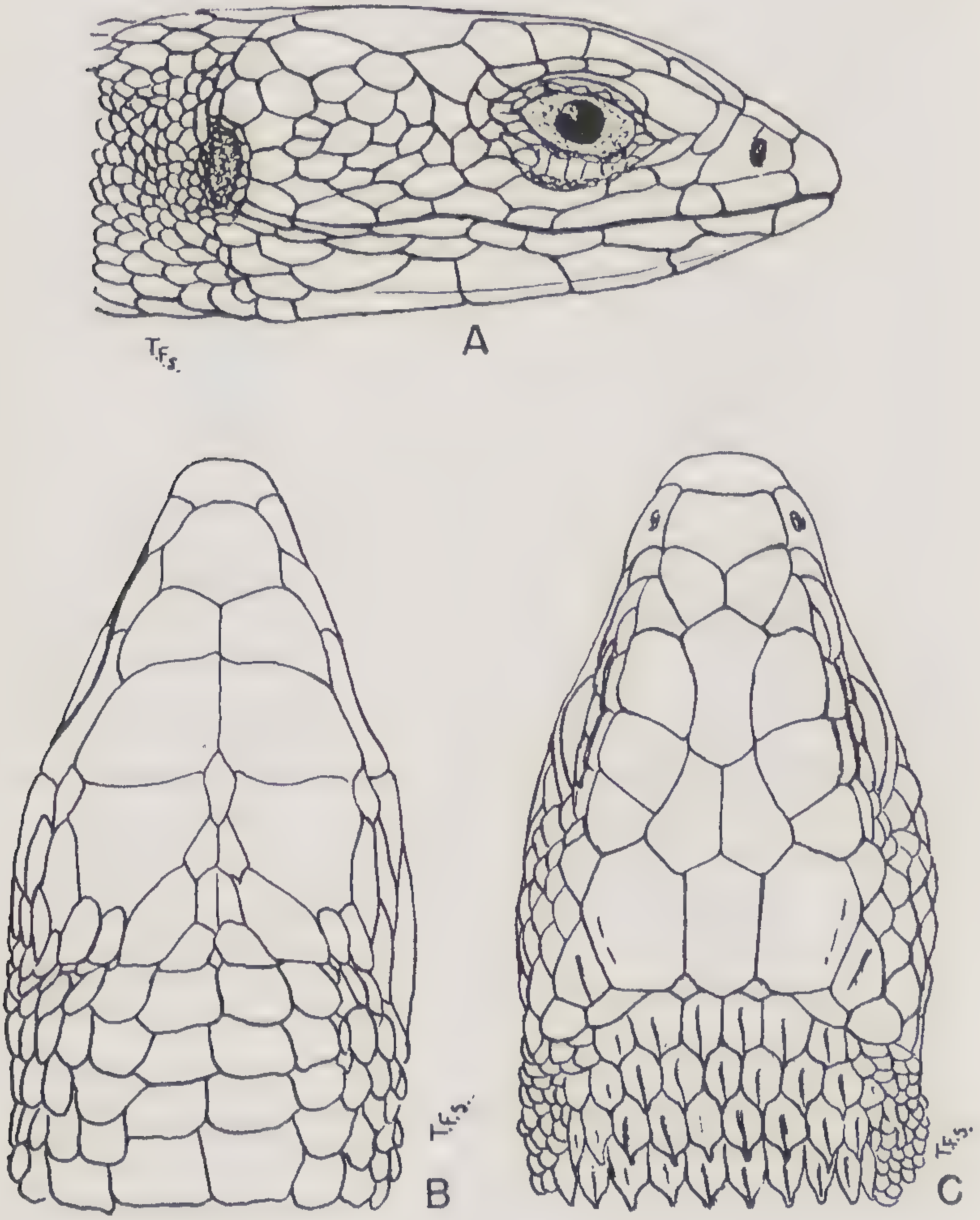

FIG. 63. *Ptychoglossus plicatus* (Taylor). KUMNH No. 23800, type; five miles southwest Turrialba, C. R., Morehouse Finca (not Morehead). A. Head lateral view; B. Head ventral view; C. Head dorsal view. Actual length, tip of snout to ear, 11.6 mm.

with labials laterally, third pair separated mesially from each other and from labials laterally, followed by an enlarged pair of scales separated mesially; six transverse rows of smooth scales between this last pair of scales and the groove formed by gular collar; six rows of temporal scales, posterior scale of upper row largest, somewhat ridged; some slight ridges on some of the other temporal scales; auricular opening large.

Dorsal scales strongly keeled, their sides more or less parallel, terminating in a spine, continuing to tip of tail; scales forming transverse rows. Lateral scales on neck small, smooth, irregular in size; around arm insertion a rather large granular area present, and a similar one of lesser extent about leg insertion.

Ventral scales of breast and abdomen large, quadrangular, smooth, beginning at collar where scales are slightly curved, and continuing back to level of thigh, arranged in four longitudinal rows and sixteen transverse rows, the outer larger than inner; outer row on each side bordered by a series of somewhat enlarged scales about one half as wide; scales under tail smooth; four elongate anal scales, outer smaller than inner, separated from the last modified row of the abdominal series by a row of small scales, two on each side, bearing femoral pores; total series of femoral and preanal pores 12 (13) on each side.

Arms and legs moderately developed, pentadactyl; digits well developed and clawed; anterior surface of arm with large smooth irregularly shaped scales; those on back and ventral surface much smaller; front scales on thigh smooth and large; dorsal scales on thigh smaller, strongly keeled; posterior thigh surface covered with granular scales; under surface of tibia with large smooth scales; those on other surfaces smaller, keeled; two enlarged scales, each with a sharp cutting edge, at base of first finger.

Each side of tongue decorated with a regular series of plicae that run forward to medial line, forming 24 chevrons; posteriorly there are eight or nine rows on each side that fail to meet in the middle.

Measurements (in mm.): Snout to vent, 50; snout to arm, 19.2; axilla to groin, 25; head width, 8.4; snout to ear, 11.6; tail, 60 (regenerated); arm, 13; leg, 19.5.

Color in life: Head nearly uniform mahogany brown, slightly darker in supraorbital region; back slightly reddish-brown with numerous dark flecks; a dorsolateral light line from above tympanum to behind level of arm insertion; sides blackish, but with very numerous cream-white flecks, some suggesting lines; venter cream with numerous black spots or flecks; black marks on the ventral scales are largely on scale edges and these, being contiguous, tend to form irregular black stripes. Chin with rounded dark spots.

Tail partly regenerated, proximal part colored much like body; ventrally, dark spotting tends to form transverse rows of dots or

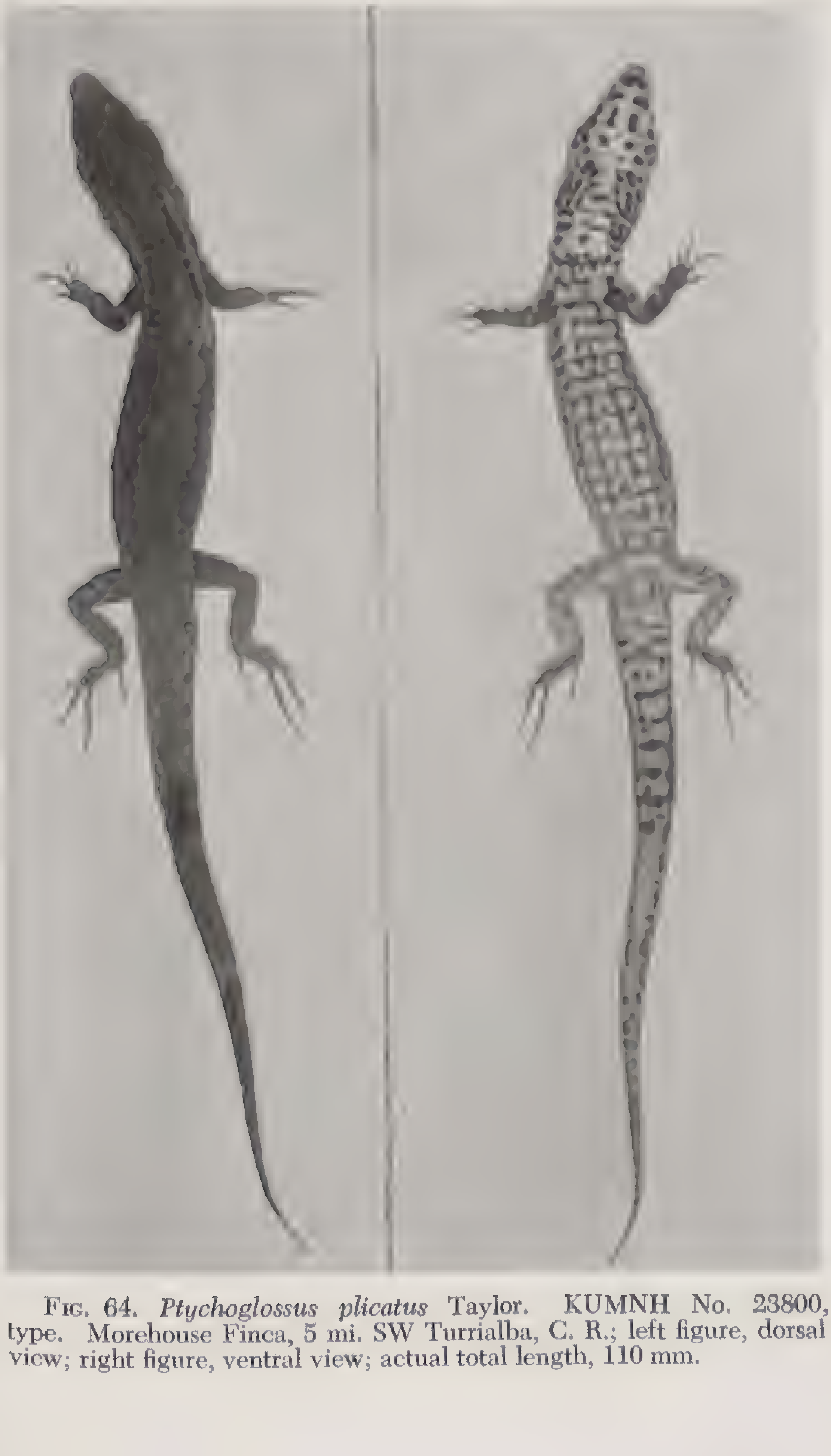

FIG. 64. *Ptychoglossus plicatus* Taylor. KUMNH No. 23800, type. Morehouse Finca, 5 mi. SW Turrialba, C. R.; left figure, dorsal view; right figure, ventral view; actual total length, 110 mm.

narrow irregular bars; regenerated portion of tail much lighter with a reddish cast; only a few minute dark flecks on sides and a very few on underside. There is somewhat more black mixed in dorsal coloration of body in area between the two anterior dorsal light lines, this area being considerably darker than elsewhere.

Remarks: Aside from the holotype and paratype, the following small series from Costa Rica is in the collection: KUMNH Nos. 31468-31475, Moravia de Chirripó, Cartago Province; Nos. 31476-31478, La Lola, Limón Province.

Variation and relationship: This placing of this species in the genus *Ptychoglossus* rather than in *Alopoglossus* calls decided attention to the number of characteristics the two genera have in common, and the relatively small number of constant characters that differentiate them.

Ruibal who has made the most recent comparative study states that "*Ptychoglossus* in contrast to *Alopoglossus* is characterized by much smaller dorsal scales which have parallel sides and are in perfect transverse rows; by having the gulars quadrangular and subimbricate, and by having the ventrals rectangular or quadrangular, with the posterior borders truncate" . . . "It may also be added that all species of *Alopoglossus* have keeled scales on the forelimbs whereas the species of *Ptychoglossus* all have smooth scales."

An examination of these contrasting characters in *Ptychoglossus plicatus*, shows that the scales of the dorsum and sides are small and in transverse rows, and they usually have parallel sides. However, as the rows approach the ventral scales some may not be parallel-sided, and there is an extensive postaxillary and supra-axillary area covered with small, rounded scales or granules. The ventral scales anteriorly are generally quadrangular, the posterior edge more or less truncate but posteriorly on venter the edges are more often rounded and in the region anterior to the anal scales they may be narrowed and somewhat pointed.

The gulars are strongly variable and seemingly there is a sex difference in these scales. The usual arrangement has larger paired median scales juxtaposed on the median line and laterally imbricating. However, the median series may be separated, the scales in transverse rows may be different in number and size. In males the posterior part of the scales on the outer posterior side of the arm and upper part of the leg are keeled. Following the third pair of chinshields there is a pair of enlarged scales often diagonally placed, *Measurements in mm. and scale data from Ptychoglossus plicatus*

Number	Sex	Snout-vent length	Total length	Tail	Snout to foreleg	Axilla-groin	Arm	Leg	Supra-labials	Infra-labials	Scales around middle	Scales occiput above vent	Preanal pores	Femoral pores	Sub-caudals
34171........	♂	56.5	143	86 5	22	29	15	22.5	7 7	5-5	35	30	11 11	2-2	58*
34172.........	♂	60	155	95	22	28.5	16	23	7-7	5-5	35	31	10-10	2-2	58
34175........	♀	54	157	103	18 5	28 5	13	20 5	7-7	5-5	35	32	0-0	1 1	79
34170.........	♂	49	134	85	19 5	25 2	15 2	22	6-6**	5-5	34	32	9 9	2-2	69*
34168........	♀	46 3	....†	..	17 5	23	13 2	19.6	6-6†	5-5	34	30	0-0	0 0	..
34176.........	♂	47.5	910	43 5	18	23	13	18 2	7 7	5-5	34	32	9-9	2-2	*
34177.....	♀	46.5	111	64 5	17.8	24	12 2	17 6	7-7	6-5	35	32	0 1	0-1	.. *
34178.........	♂	43	. †	.....	16	21	14	18 5	7-7	5-5	33	32	12-11	2-2	
34174.......	♂	27	67	40	11	12.5	8	11	7-7	5 5	33	32	11-11	2 2	79
34173.......	♂	31	...	...	12	14.5	8 3	13	7-7	5-5	35	33	10 10	2-2	...

* Regenerated.
** One and two fused.
† Broken.
‡ Sixth and seventh fused.

and separated mesially that are constant in the form under consideration.

Sexual variation is evident. Males are darker brown on back and sides with a scattering of dark pigment, more pronounced laterally. Here a large number of scales likewise have cream or whitish flecks. The venter is generally ivory or cream with considerable dark flecking on chin, throat, breast (sometimes the dots forming somewhat transverse lines). On the venter the pigment follows the scale borders and five irregular more or less continuous lines may be in evidence in older males. The dorsolateral tan or brownish cream line varies in its length and distinctness. Under the tail the pigment is arranged more in indistinct irregular transverse rows or lines.

Adult females are lighter brown with no or much less dorsal black pigment; sides of head and neck with some small dark dots or flecks, less distinct on sides; chin with two or very few small dots, venter and subcaudal region, except near tip, creamy ivory.

Very young males as well as females have no dark pigment. In the males the pigment is acquired gradually as the animal grows older.

Variation in head scales was noted but not recorded save in the case of the labials. There were seven supralabials and five infralabials (followed by one or two very small or granular scales). Two cases of six supralabials resulted from the fusion of the first and second labials in one case, and fusion of the sixth and seventh labials in another.

The variation in scales around the middle of the body is from 35 in the largest, 34-35 in intermediate size, and 33 in the smaller. The subcaudal scales are close to 79 where the tail is unbroken and not regenerated. Femoral pores in males varied from nine to twelve while two preanal pores on each side was constant. In females there were no femoral pores discerned; however, in two specimens, preanal pores were found, in one, on one side only, and in one, a single pore was present on each side.

Genus AMEIVA Cuvier

Ameiva, Cuvier, Règne Animal, vol. 3, p. 27 (type of the genus, *Ameiva ameiva*).

Five species and subspecies of *Ameiva* occur in Costa Rica. Another species *Ameiva praesignis* is found in Panamá and may also inhabit parts of Costa Rica. However, I believe no specimens are as yet known from that State.

KEY TO SPECIES OF AMEIVA IN COSTA RICA

1. Two pairs of parietals; the interparietal separated from them and the frontoparietals by small scales; brown above, olivaceous below; a dorsolateral series of dark brown spots . . . . *leptophrys*
   A single pair of parietals, the interparietal not separated from parietals and frontoparietals by small scales 2
2. A well-defined median stripe of cream, greenish yellow or blue (variable with age) 3
   No well-defined median light stripe 4
3. A longitudinal lateral black or dark band bordered above and below by a series of cream or yellow-green dashed marks forming a continuous series; often some lighter spots low on sides . . *Ameiva festiva festiva*
   No black longitudinal lateral band. Dorsolateral dark region with a series of light dots, occasionally with light flecks above axillary region . . . . *Ameiva festiva occidentalis*
4. Normally two loreals; dorsum olive with black flecks; sides of males with vertical irregular bars of olive or yellowish green or greenish-blue separated by similar bars of black; females with lateral bars less distinct and a narrow dorsolateral light line and a lateral cream line; between the two lines usually olive or yellowish green spots separated by black; hind legs flecked or reticulated with yellowish. *undulata parva*
   Normally one loreal; four large median mesoptychial scales followed on each side by smaller ones; color brownish black above, jet black on the sides. Back vermiculated with black, the sides white-spotted; two narrow white lines from temples to groin. A single series of enlarged scutes on upper surface of forearm . . . . *quadrilineata*

Ameiva leptophrys Cope

Ameiva leptophrys Cope, Proc. Amer. Philos. Soc., vol. 31, 1893, pp. 341-342 (type locality Buenos Ayres [= Aires] Puntarenas Province, Costa Rica); Dunn, Proc. Acad. Nat. Sci. Philadelphia, vol. 92, 1940, p. 114.

Ameiva ruthveni Barbour and Noble, Bull. Mus. Comp. Zool., Harvard Col. vol. 59, 1915, p. 471 (type locality, near city of Panamá, Panamá.)

The species *Ameiva ruthveni* was described by Barbour and Noble, seemingly without their being aware of the previous description of the form under the name *leptophrys* by Cope.

Diagnosis: A large species having the interparietal separated from parietals and frontoparietals by small scales, the area involved in a distinct depression; femoral pores, 22-29, average 25.5; gular scales smaller than mesoptychial scales; preanal relatively small; eight ventral rows of transverse scutes the outer for much of its length as wide as adjoining row; a small second loreal; two enlarged rows of temporals; lacking distinct median or lateral lines.

Description of species (From R.C.T. No. 957, San Isidro del General Aug. 21, 1947, Richard C. Taylor Coll.): Part of rostral visible above less than half as long as the frontonasal which is a fifth longer than wide; suture between nasals a little less than one third of the length of nasal scales; nostril in suture between the two nasals and first labial; frontal slightly longer than broad, touching first two supraoculars; frontoparietals irregular, in contact, separated from the supraoculars; parietals very much reduced, divided into three or four scales forming a widely diverging row behind the frontoparietals. Interparietals divided, separated from other parietals by two or more rows of small scales; at least five rows of scales behind the interparietals; three supraoculars, the anterior separated from loreal, the first two touch the frontal, the third wider than long, separated from the frontal, parietals, and supraciliaries by two or more rows of granules; loreal large, longer than high, touching two labials; a small posterior loreal segmented from preocular, a small upper preocular, and a large keeled preocular with one or two enlarged scales behind, bordering inner edge of the orbit; a single presubocular, and an elongate subocular both also keeled, the keels forming a curving line; a complete row of somewhat enlarged scales follow the inner edge of the orbit; about six postsuboculars and postoculars together; two longitudinal rows of enlarged temporals; six supraciliaries, the third greatly elongated; four enlarged scutes on opaque part of eyelid; about seven supralabials; about six infralabials, the back part of lips bordered by granules; mental with a labial border much longer than that of rostral; first upper labial denticulate; postmental more than twice as long as mental; five pairs of chinshields, the first pair in contact anteriorly, second may or may not touch labials, the others following are separated from the labials; several rows of somewhat enlarged gulars forming a somewhat triangular patch; mesoptychial scales in a transverse series of eight or nine, the median largest, the row preceding and following slightly enlarged; about 15 rows of granules in the mesoptychial fold; an anterior nuchal fold; body covered with more or less uniform conical or trihedral granules, slightly larger along edge of ventral scutes; tail covered with elongate keeled quadrangular scales, the keels not forming continuous straight lines; base of tail flattened, the dorsolateral scales heavily keeled, the keels terminating in short spines or mucrones; scales under base of tail, smooth; posterior to the vent are about four rows of granules followed on each side by three scales, in turn followed by a wider, larger "postanal" scale, the two groups separated from each other by four or five tiny scales; (these "postanals" are not or scarcely developed in females); preanal scales arranged in four pairs (not symmetrical), the entire series surrounded by a series of smaller scales; ventral plates in eight rows, the outer row, small at first, becomes as wide as adjoining row; about 29 transverse rows on venter followed by two or three paired scales between thighs.

Upper arm with a row of seven large scutes with a few somewhat enlarged scales around the first; forearm with two series of enlarged scutes, the upper row continuous with the series on upper arm; scales under forearm, conical tubercles increasing in size distally, with a series of four rather flat enlarged scales terminating at base of palm in a large shovel-shaped scale; front and under side of femur with three much enlarged distal scutes, proximally the scales are smaller in about 12 rows; femoral pores, 28-29, the pores typically surrounded by one larger scale and from two to four others; two enlarged series of scutes under tibia bordered posteriorly by a smaller irregular row. The subdigital lamella of the fourth toe, 32-33, the scales single except below joints, compressed, serrate.

Color in life: Above deep brown (becoming greenish olive when keeled), with some indistinct narrow blackish or dark olive transverse markings; heavy black spots on side bordering the dorsolateral line separated at first by very narrow yellow green lines that widen lower on side, the black spots developing two prongs below. Chin and throat magenta to lavender purple with a faint metallic iridescense. Belly dull orange. Dark olive under limbs.

Measurements in mm.: Snout to vent, 128; tail (regenerated); snout to ear, 34; axilla to groin, 53; snout to arm insertion, 52; head length, 40; head width, 25; arm, 49; leg, 103.

Variation: There are eight specimens available including three in the RCT collections. These are KUMNH Nos. 34766-34770 Esquinas forest preserve, between Palmar and Golfito (on railway), Puntarenas Province; RCT Nos. 957, 3019, 3020 from San Isidro del General, San José Province.

The femoral pores vary between 22 and 29. The lowest count 22-23 is from a young female (34770) and the highest 28-29 from the specimen described. The average is 25.5.

Counts of the granules about body vary between 159-168. It is possible that the range is a little greater owing to uncertainty of making counts at the same exact point.

The character of the preanals varies. Usually there are three or two small scales preceding the vent; in front of these is usually a single median scale preceded by a single scale, this preceded by a small pair. The single scales are small when compared with most

Costa Rican species of *Ameiva.* Two young specimens, RCT Nos. 3019, 3020, are curious in having a median prefrontal followed by the frontal which is divided into four scales (somewhat irregular pairs); there are three frontoparietals.

One specimen 34770 has an extra supraocular severed from the second. The second small loreal is normally present. In one case it is a part of the preocular; in another it was fused to the anterior loreal.

Scales on the regenerated tails are less than half the size of the original scutes but all are keeled.

Remarks: In the vicinity of San Isidro del General, *Ameiva leptophrys, Ameiva quadrilineatus* and *Ameiva festiva occidentalis* occur. None of these forms should be considered rare but there is unquestionably a meager population when compared with *Ameiva festiva festiva* in the eastern and northeastern lowlands as for example Los Diamantes (near Guápiles) and La Lola. Here that species was represented by a large population.

Ameiva festiva

In Costa Rica the populations of *Ameiva festiva* appear to be distinct on the two coasts.

KEY TO FORMS OF AMEIVA FESTIVA LICHTENSTEIN AND VON MARTENS

1. A narrow sinuous-edged median stripe from snout to tail covering from eight to ten rows of granules. Dorsum olive or olive brown with black spots or a continuous line of black bordering stripe; a black lateral stripe with a line of dashes bordering it above and below, lower sides with or without bluish dots and lines. (Eastern and northern Costa Rica) .... *Ameiva festiva festiva*
2. A median stripe covering 14 to 20 rows of granules at the widest parts, edged with cream; this line bordered by a series of black spots or a dark irregular line. A dorsolateral series of rounded or dashed cream marks, the dashes somewhat curving or irregular not forming straight lines; sides olive, but no line of any kind from axilla to groin and no light marks low on sides, rarely one or two marks above axillary region. (Southwestern Costa Rica), *ameiva festiva occidentalis* subsp. nov.

Ameiva festiva festiva Lichtenstein and von Martens

(Fig. 65)

Cnemidophorus festivus Lichtenstein and von Martens, Nomenclator Reptilium et Amphibiorum Musei Zoologici Berolinensis, 1856, Berlin, p. 13 (type locality, Veragoa = [Veragua,] Panamá. The type is figured by Bocourt *loc. cit.*).

Ameiva eutropia Cope, Proc. Acad. Nat. Sci. Philadelphia, vol. 14, 1862, p. 62 (type locality, "Region of the Truando, New Granada"); and *idem,* 1874, p. 68 (Nicaragua).

Ameiva edwardsii Bocourt, Ann. Sci. Nat., vol. 17, 1873, art. 17.

Ameiva festiva Bocourt, Mission Scientifique au Mexique et dans l'Amérique Centrale; Études sur les reptiles, livr. 3, 1874, p. 260, pl. 20 A, fig. 10; pl. 20 D, fig. 3; pl. 20, fig. 2; Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, 1876 (1875), p. 117 (Costa Rica); Günther, Biologia Centrali-Americana; Reptilia and Batrachia, May 1885, p. 24 (Guatemala, Costa Rica, Panamá); Cope, U. S. Nat. Mus. Bull. 32, 1887, p. 44; Barbour and Noble, Bull. Mus. Comp. Zool. Harvard College, vol. 59, Oct. 1915, pp. 473-474.

Ameiva festiva festiva Dunn, Proc. Acad. Nat. Sci. Philadelphia, vol. 92, 1940, pp. 114-115.

Diagnosis: Nostril largely in anterior nasal; a single large loreal about as high as long; no second loreal, the preocular reaching the fourth supralabial; eight series of ventral plates, the outer on each side often distinctly smaller than adjoining row; mesoptychial scales about nine in a single continuous transverse row; large scutes on anterior part of upper arm, in a single row of eight; on posterior face four enlarged shields; on forearm a single series of five, followed proximally by two pairs of smaller scales; a median cream or greenish blue stripe, variable in width; a black lateral stripe, bordered above and below by a dashed cream line.

Description of species (From KUMNH No. 40537, between Puerto Viejo and Cariblanco, Heredia Province): Length of rostral visible above very little more than half that of frontonasal; nasals forming a suture equal to one third of their length; frontonasal separated from the loreal, in contact laterally with both nasals; frontal very slightly wider anteriorly than posteriorly, hexagonal, touching two supraoculars; frontoparietals divided, wider posteriorly with (abnormally) a small outer posterior scale segmented from them; parietals separated by the interparietal which is a little smaller; about four rows of occipital scales, the largest bordering parietals behind and on sides; three supraoculars, the anterior smallest; second forming a long suture with the frontal, but separated from the very elongate supraciliary by a row of tiny granules; third supraocular separated from interparietal and supraciliaries by one to three rows of granules; supraciliaries five (six on right side) the second greatly elongated, about half length of orbit; nostril in suture between the two nasals, but chiefly in anterior scale; both nasals touching two supralabials; loreal large, about as long as high, touching second and third labials; a large preocular touching fourth supralabial, followed by a presubocular and an elongate subocular, the three scales with keels that together form a curved line; about six postsuboculars and postoculars with an inner row of scales preceding suboculars; a horizontal row of temporal scales, the largest abuts on upper postocular; eight supra-

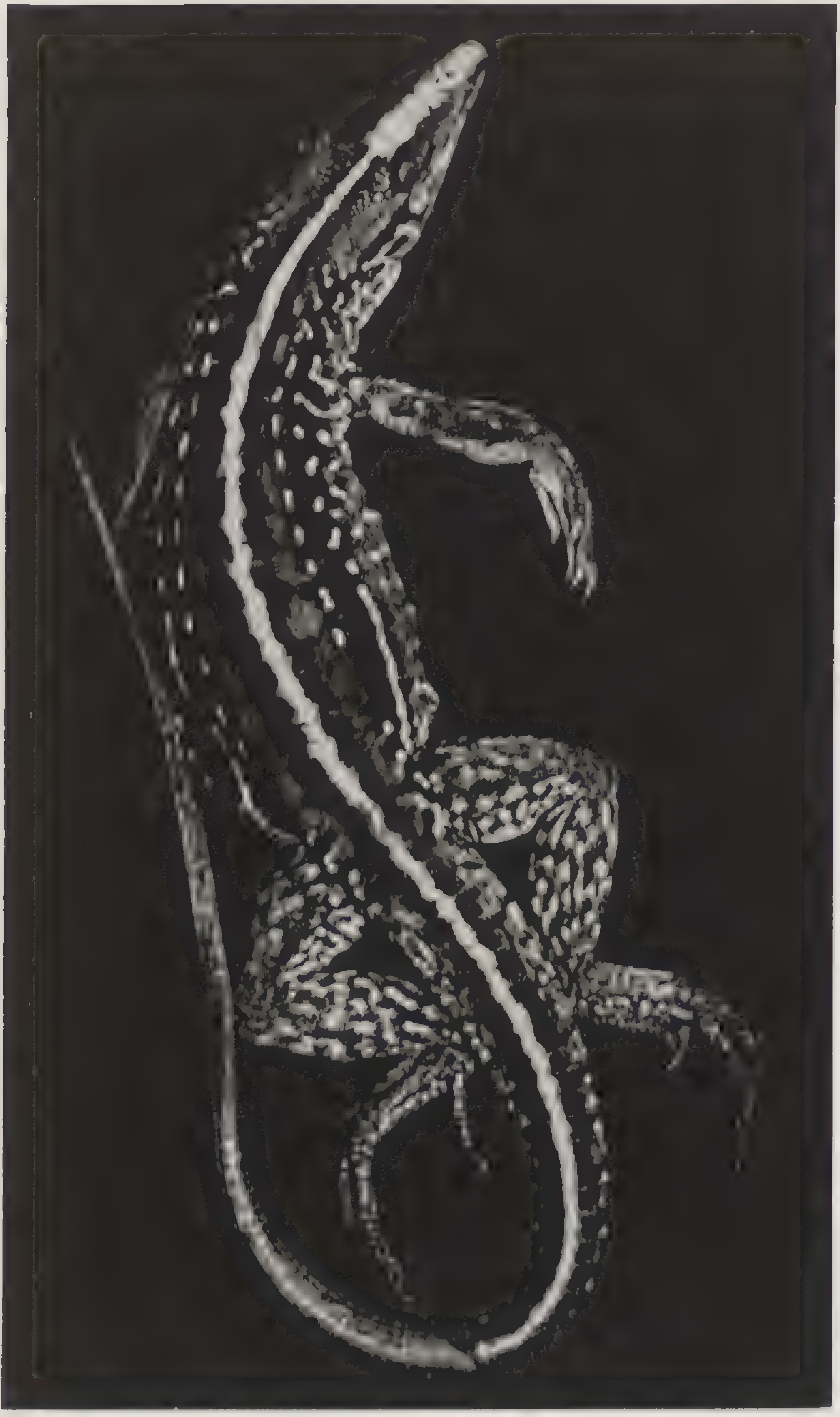

FIG. 65. *Ameiva festiva festiva* Lichtenstein and von Martens. KUMNH No. 40537. Between La Virgen and Puerto Viejo, Heredia Province; actual total length, 228 mm.

labials, the labial edge of first denticulate; five (six) infralabials the posterior part of mouth bordered by undifferentiated granules; lower eyelid somewhat opaque with two to four large scales, of which the two or three median are the largest; mental with a much wider labial border than rostral; an azygos postmental (a section abnormally segmented from the posterior part of scale); first chinshields separated by granules, second to fifth pairs separated from their fellows and from the infralabials; a group of distinctly enlarged gulars; the two series of scales on each side of this group directed toward tympanum are of subequal size; two gular folds; the mesoptychial scales ten, forming a transverse row, the median largest; about 26 rows of granules following mesoptychials; ventral scales in 27 transverse rows, somewhat irregular on breast; anteriorly on venter six rows of plates; more posteriorly eight rows, the outer row for part of distance about equal to width of adjoining row; a pair of anal plates precede the vent, and these likewise preceded by a large azygos scale; three much smaller scales border this azygos scale.

A row of eight shields on front of upper arm connecting with a series on the front of forearm, the proximal three broken forming pairs; a row of four large scutes on the back of upper arm; two or three enlarged scutes on base of palm; lamellae irregular, about 17 under two longest fingers; leg elongate reaching loreal scale when brought forward; several rows of enlarged femoral scutes, contiguous with the paired series below the tibia; subdigital scales extremely irregular as if the median series had been partly pushed to one side allowing another lateral series to encroach under joints; fourth toe with about 27-28 scales or pairs of scales, presenting a rough surface.

Caudal scales enlarged, rectangular, keeled (except under base of tail) forming transverse whorls, the first two or three are broken behind vent by numerous small granules; the dorsal keels are practically parallel to the sides of the scales and tend to form continuous lines. Body above and on sides covered with small conical granules, about 205 in a row about middle; femoral pores 20-21; a small skinfold from axilla to groin; ear-opening large, the tympanum rather deeply sunk; tail somewhat flattened the upper lateral rows heavily keeled the keels terminating in spines or mucrones and forming a discernible lateral serration.

Color in life: Above dark olive with a median greenish-blue line beginning on frontoparietals, continuing far onto the tail, its borders somewhat sinuous; on each side of this are darker areas tending to form an indefinite line. A dorsolateral series of dashed bluish-cream spots extending on to the base of tail; this bordered laterally by a deep black stripe; this bordered below by a second series of dashes which may fuse posteriorly. Below this a scattered series of irregular, usually vertically-placed, bluish-cream spots; posterior part of limbs blackish with bluish-cream spots or flecks; median part of top of head yellowish green, blackish on sides; labials ultramarine; venter dull putty-white, somewhat bluish on under part of tail; numerous black flecks on dorsal part of tail.

Measurements in mm.: KUMNH 40537, 40541, 40559. Snout to vent, 85, 113, 117; tail, 143, —, 202; snout to ear, 22, 30, 31; snout to arm insertion, 36, 47, 46; length of head, 24.8, 36, 36; width of head, 14, 23, 23; axilla to groin, 35, 52, 56; arm, 35, 38, 42; leg, 68, 90, 93.

Remarks: This gaily colored species is especially common in the eastern lowlands. I found most of them at open spots in forest or along pathways where they could hunt in the sun. They were most active at about ten o'clock in the morning. The general color pattern is maintained without much change in age groups. Squamational variation is considerable.

*Ameiva festiva occidentalis** subsp. nov.

(Fig. 66)

Type: R. C. T. No. 874, 5 mi. E San Isidro del General, San José Province, collected Aug. 23, 1947 by Richard C. Taylor.

Paratypes: R. C. T. No. 873, Topotype same data as type. KUMNH Nos. 40545-48, 40553, 40554-58 Agua Buena, Cañas Gordas; 40549-50, 15 km. WSW San Isidro del General, Puntarenas Province.

Diagnosis: Differs from *Ameiva festiva festiva* in lacking a broad black lateral stripe bordered below by a series of cream or greenish-blue dots or dashes; median sinuous or zigzag stripe covers 19-20 rows of granules at widest points; it begins on occiput, in adults, but is continued on head in young as a dim yellowish line or stripe; blue median stripe continues on tail in young, obsolete on tail of adults; 180 granular rows about body.

Description of type: Part of rostral visible above about four fifths of the length of frontoparietal; suture between anterior nasals little more than one fourth length of scales; frontonasal longer than wide, shorter than prefrontals or frontal; prefrontals form a median suture

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* From Latin *occidentalis*—of the west.

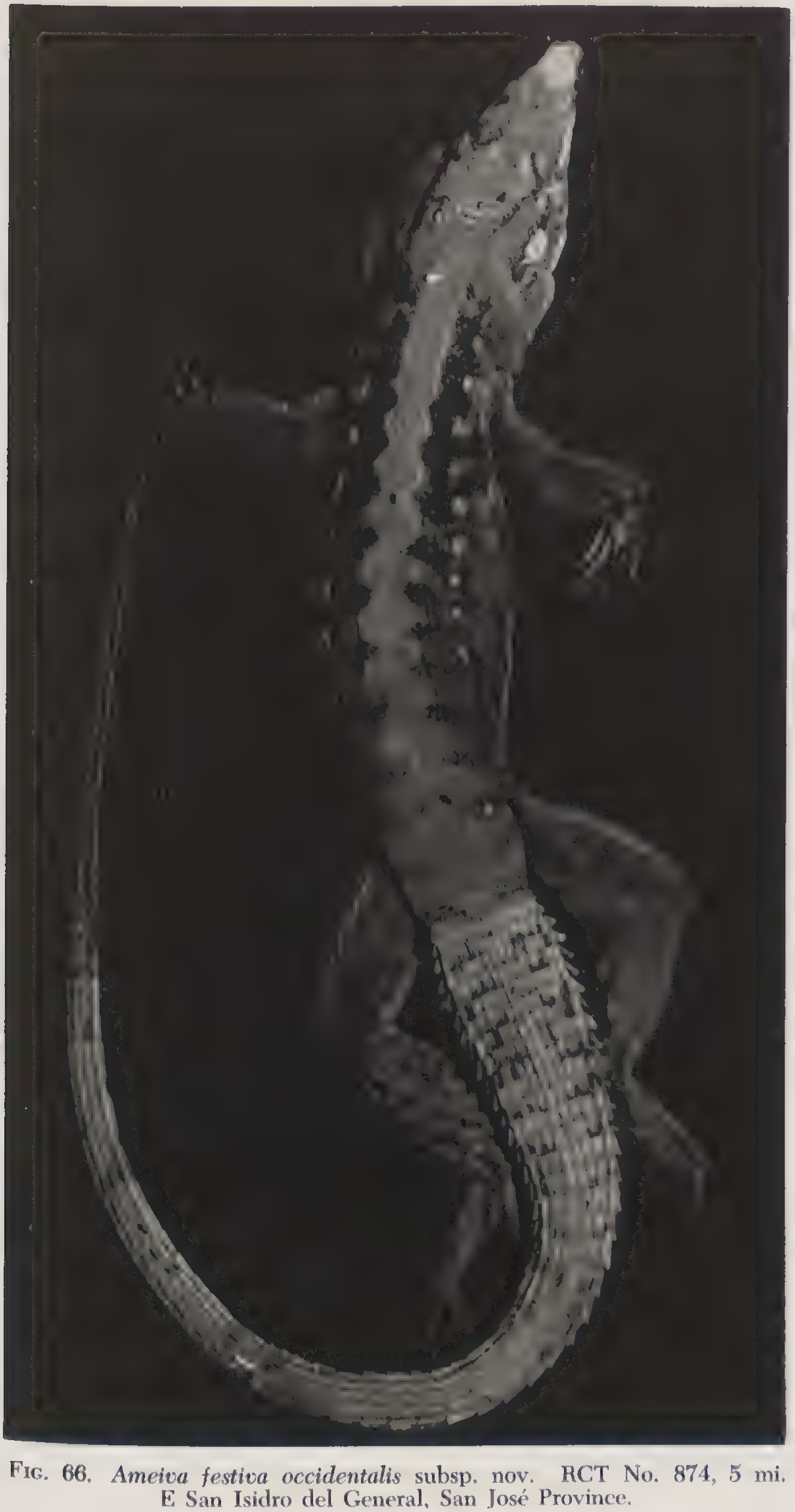

Fig. 66. *Ameiva festiva occidentalis* subsp. nov. RCT No. 874, 5 mi. E San Isidro del General, San José Province.

less than half length of the scales; frontal hexagonal, in contact with three supraoculars, its length about equal to its distance from the rostral; a pair of short frontoparietals in contact with third supraocular at a point, separated from it by from one to three rows of granules elsewhere; parietals broader than long, separated by an interparietal that is longer than parietal, definitely hexagonal; parietals followed by three or four rows of scales diminishing in size posteriorly, the first row continued on sides of parietals up to the frontoparietals; nostril in suture between nasals and first supralabial; loreal large, only a little longer than high, separated from contact with anterior supraocular; an elongate preocular bordering third and fourth supralabials, followed by two presuboculars and these by an elongate subocular, the first three scales with curving keels that tend to form a continuous line, the keel partly obsolete on the subocular; an enlarged postsubocular and about three rows of postoculars; a longitudinal temporal row of somewhat enlarged scales; scales of preauricular region slightly enlarged; supraoculars three, the anterior two longer than wide, the third wider than long, only first touching supraciliaries of which there are seven on the right and five on the left, the second much elongate; eight supralabials; infralabials seven (eight), first small. Mental large with a labial border much greater than rostral; an azygos postmental; five pairs of chinshields, only the first partly in contact with each other; the first two pairs in contact with infralabials; a series of five much-enlarged gulars, the vertical rows of scales on each side of this group subequal out as far as the swollen subtympanic area. Mesoptychial scales, three on one side, four on the other, the median scales largest, in contact, the series followed by small granules; about 21 granular rows in the second fold; venter with six rows of enlarged plates and a partial row of 5-(7) seemingly segmented from the posterior part of the series but not continuing to groin; the scales of the preceding and following outer series as wide as the adjoining row; about 29 transverse scalerows from nuchal fold to posterior part of abdomen; a pair of preanals preceded by a large azygos scale equally as wide as the pair; these surrounded by a row of small scales the anteriormost pair largest. Caudals enlarged, arranged in transverse rows; except at base of tail (postanal region) all scales strongly keeled, the keels forming longitudinal lines; top of tail flattened especially on proximal fourth, the dorsolateral rows of scales with the keels terminating in elevated spines or mucrones.

Seven enlarged scutes on front of upper arm; four large scutes on forearm, separated from previous series by three pairs of smaller scales; under forearm somewhat enlarged conical tubercles; ventral surface of femora with three rows of large scutes distally, about five smaller rows proximally, the larger scutes separated from pore-scales except distally; two large series of scutes under tibia.

A dim lateral skin fold from axilla to groin; tympanum rather deeply sunk; femoral pores 19-19.

Color in life: Dorsum olive brown with a broad median yellowish-green to bluish-green notched or sinuous stripe running from occiput to base of tail; top of head brownish; a series of black spots fit into the notches on median stripe, the spots becoming less distinct in lumbar region; a dorsolateral series of dashed cream lines (sometimes vermiculate) extending from side of neck to above groin; sides uniform olive; venter bluish or ultramarine.

Measurements in mm.: Snout to vent, 104; tail, 273; length of head 29; width of head, 16; snout tip to ear, 25; snout to arm insertion, 38.2; arm, 41; leg, 86.

Variation: In younger specimens the dorsum is nearly black, the median line blue extending to tip of snout and nearly to tip of tail; the dashed line begins at the eye, and there may be bluish lateral vermiculations connecting with the spots forming the dorsolateral line.

While the type has two suboculars, this condition appears to vary in the paratypes; the preocular is sometimes segmented forming a small posterior loreal or the size of the preocular may be reduced and widely separated from the supralabials while its lower part is presumably fused with the large (anterior) loreal or the preocular may be segmented so that the second loreal may enter the orbit rim and form a third presubocular. I find one specimen with the frontoparietals segmented so as to form two regular pairs, and in the same there were other segmentations in the parietal series. One specimen has the third supraocular separated from the frontal by granules.

Femoral pores vary between 17 and 23, most however have 19, 20 or 21, the last being most frequent.

The relationship between the loreal and the anterior supraocular varies. The normal condition appears to be contact between the two scales. However, in one specimen from San Isidro del General, and three from a point west-southwest about 15 kilometers, and one from Agua Buena, these scales are separated.

One specimen from San Isidro was remarkable in having only six large ventral series. In most of these western specimens there is usually a short series representing the fourth row on each side, sometimes reduced to six or eight scutes.

The specimens from Agua Buena frequently have the interparietal a little longer than the parietals. In a few cases the posterior supraocular is separated from the frontoparietals and the frontal by small granules. As may be expected a variation of eight or ten in the count of the granules about the middle of the body occurs. The aspect of the head scales is fairly constant.

Ameiva undulata parva Barbour and Noble

(Fig. 67)

Ameiva undulata parva Barbour and Noble, Bull. Mus. Comp. Zool., vol. 59, 1915, pp. 476-477 (type locality, Mazatenango, Guatemala [by restriction], type, Mus. Comp. Zool. No. 5831; Van Patten Coll.); Bocourt, Mission Scientifique au Mexique et dans l'Amérique Centrale; Études sur les reptiles, livr. 3, 1874, pp. 254-258 (*part.*); Günther, Biologia Centrali-Americana; Reptilia and Batrachia, 1885; p. 23, Boulenger, Catalogue of the lizards in the British Museum, 2nd Ed vol. 2, 1885, pp. 347-348 (*part.*).

Ameiva undulata (*part.*) Dunn, Proc. Acad. Nat. Sci. Philadelphia, vol. 92, 1940, pp. 114-115 (synonymizes *Cnemidophorus amivoides* Cope, *Ameiva pulchra* Hallowell, *Ameiva undulata quadrilineata* Barbour and Noble and *Ameiva miadis* Barbour and Loveridge, with this species); Smith and Laufe, Univ. Kansas Sci. Bull., vol. 31, 1946, pp. 51-54, fig. 1A, pl. 2, fig. 8 (Tehuantepec to Costa Rica); Mertens, Abh. Senckenb. Naturf. Ges., no. 487, 1952, pp. 54, 55, pl. 13, figs. 73-74.

Cnemidophorus amivoides Cope, Proc. Acad. Nat. Sci. Philadelphia, 1894, pp. 198-199 (type locality La Carpintera, Costa Rica).

Diagnosis: Eight rows of abdominal plates, only six rows across breast; three supraoculars; six supraciliaries; nostril in suture between nasal scales; base of tongue not included in a sheath; a small posterior loreal, segmented from the preocular; femoral pores 17-21.

A broad dorsal band of olive or olive brown, nearly uniform, or with some black flecking; sides with about ten vertical bands of greenish blue, separated by an equal number of black marks; entire venter, chin, throat, and under limbs ultramarine. Outer ventral series of plates black with small bright greenish-blue spots in males.

Description of the subspecies (From KUMNH No. 40534 Santa Rosa, Guanacaste, C. R.): Rostral with a much shorter labial border than mental, about as high as wide; nasals forming a median suture, about one fourth the length of nasals; frontonasal hexagonal, a little longer than visible part of rostral; prefrontals forming a suture about one third length of prefrontals; frontal roughly pentagonal touching three supraoculars; interparietals paired, touching one supraocular;

interparietal a little smaller than parietals; latter separated from supraoculars by two rows of granules; three rows of differentiated occipital scales, one of which borders sides of parietals to interparietals; seven supralabials, the first forming the base of nostril, third or third and fourth largest; loreal large, longer than high touching one labial (or barely in contact with another); second loreal (frenocular) severed from preocular, small, touching one or two labials; two preoculars (the upper tiny) followed by a pre-

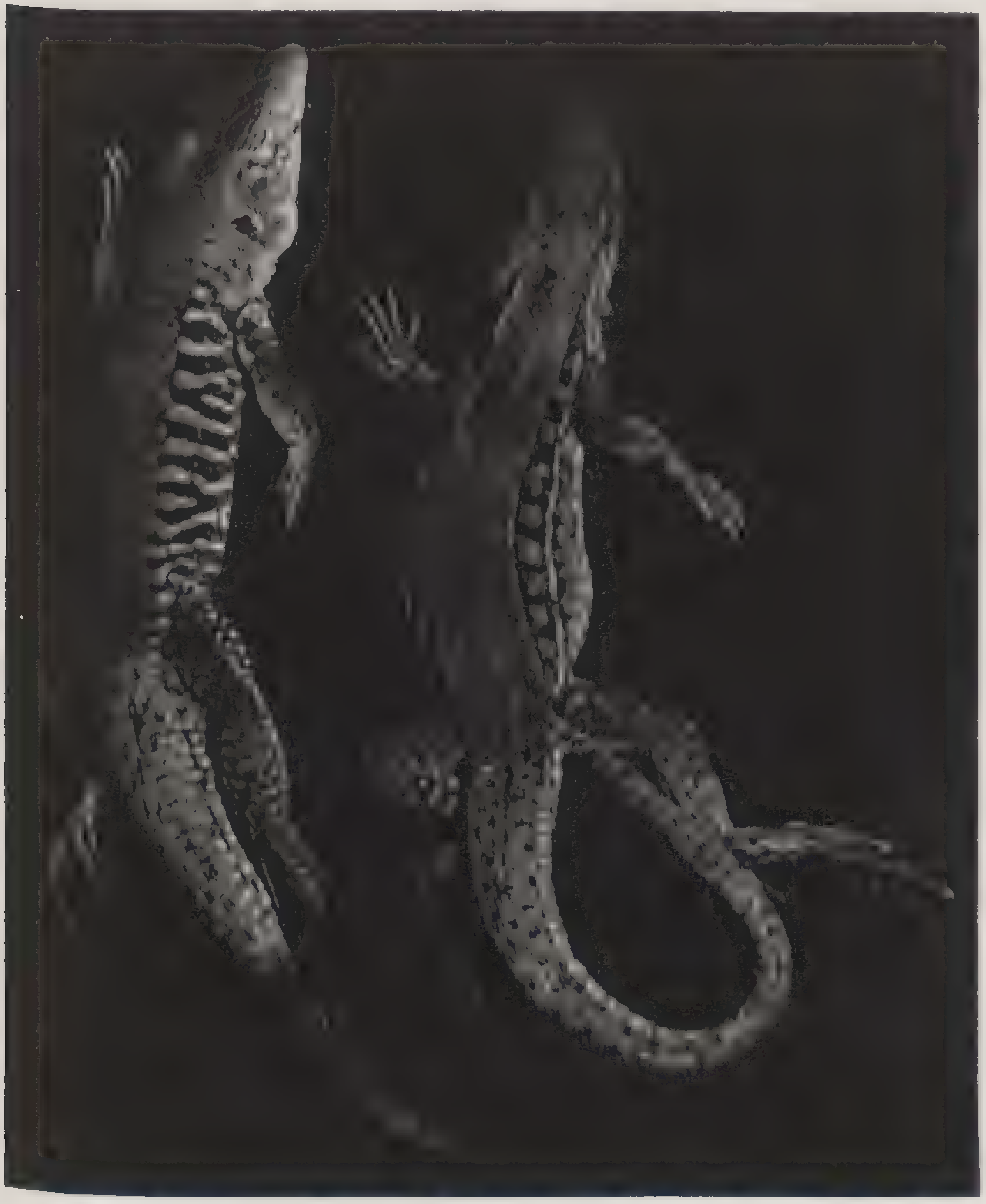

Fig. 67. *Ameiva undulata parva* Barbour. Left figure, KUMNH No. 40533; near Santa Rosa, Guanacaste, C. R. Actual length snout to vent, 92 mm.; right figure, No. 40529; Tronadero, Lake Arenal, near Tilarán, Guanacaste; actual length snout to vent, 101 mm.; total length, 200 mm. (tail broken).

subocular and an elongate subocular, the three with keels, which form a continuous line; a postsubocular; about four postoculars; five supraciliaries, the second much elongated; outer row of eyelid scales enlarged somewhat, the preocular ones distinctly elongated; at least six elongate scales on opaque upper part of lower eyelid; three supraoculars, the anterior touching one granule, second separated from supraciliaries by a row of granules, third separated from supraciliaries by two rows of granules and from a part of the frontoparietal by two rows of granules also; three rows of temporals, the anterior distinctly larger than others; five infralabials, the third largest; mental somewhat hemispherical; azygos postmental touching two labials; five pairs of chinshields, only first forming a suture with its fellow, and touching two labials; others separated from labials; a series of about six median gular scales distinctly enlarged; mesoptychial series somewhat irregular consisting of a transverse row with a smaller preceding row with a much enlarged median scale; about 19 rows of small granules in the gular fold; about 30 transverse rows of ventral plates, irregular on breast; between axillae, scales in six rows; on ventral abdominal region eight rows; three enlarged preanals, a posterior pair preceded by a large single scale, the three completely surrounded by a row of medium-sized scales.

Caudal scales enlarged, elongate, quadrangular, forming transverse series, each scale on dorsum and sides distinctly keeled, the ventral scales dimly keeled on base, strongly so distally; keels on scales not or scarcely parallel to scale edges; body generally covered with fine conical tubercles, about 154 about body.

Arm with two rows of enlarged brachials reducing to one, then on antebrachium two large rows with a third indicated at the beginning below elbow. About eleven rows of femoral scales proximally, four or five distally, two of which are much enlarged; three rows on under side of tibia; subdigital scales on toes irregular, 29-31 scales under fourth toe.

Color in life: Above, generally olive to olive brown with dark flecking almost obsolete; scales of head brownish; sides of body with series of somewhat vertical dark lines separated by similar greenish-blue lines; ventral surfaces ultramarine except in preanal and postanal region which is pinkish flesh; tail olive, becoming bluish with numerous black flecks; arms and legs olive with dim brighter markings and no longitudinal lines.

Measurements in mm. (From Nos. 40534 ♂, 40529 ♀): Snout to vent, 99, 101; tail, 181, —; length of head, 29, 28; width of head, 19.5, 16; tip of snout to ear, 25, 24; snout to arm insertion, 42, 37; axilla to groin, 43, 41.5; arm, 36, 39; leg, 70, 69 .

Variation: Females and young males show a considerable amount of dark flecking on the broad dorsal olive band, which is bounded on the sides by two bluish white narrow discrete dorsolateral lines, that arise above the tympanum and terminate at the base of the tail; a second blue-white line, continuous, dotted, or dashed, begins on the side of the neck and terminates in the groin. The large female specimen, No. 40529, has the vertical black bands represented by short black marks below the dorsolateral line, separated by light olive wider spaces; below the lateral light line the black has become obsolete; the head of course is slenderer than that of the males but the ventral coloration is much the same.

The number of femoral pores varies between 17 and 21 in the eleven specimens at hand. In the 22 counts 17 occurs four times, 18 six time, 19 seven times, 20 four times, and 21 once.

Some of the male specimens showed some magenta or purplish coloration on the throat and chin in life and the area about the vent might be yellow orange or, rarely, pink.

The swollen area below the mouth angle in males has a slight enlargement of the covering granules, however these are not continuous with the median enlarged patch of gulars or the small scales adjoining them. Regenerated tails have the scales much smaller than in the originals, and the color usually is brown.

The placing of Cope's *Cnemidophorus amivoides* is uncertain. It would appear that it should be regarded as an *Ameiva.* However the name may apply to a mountain form. I have not examined the type. The placing of the form here is tentative.

Remarks: The species is not uncommon in the Province of Guanacaste, and many specimens that were seen escaped. They move with such rapidity that they were obtained only by shooting them.

Ameiva quadrilineata Hallowell

(Fig. 68)

Cnemidophorus quadrilineatus Hallowell, Proc. Acad. Nat. Sci. Philadelphia, vol. 12, 1860, p. 483 (type locality, Nicaragua, restricted to Greytown, Nicaragua).

Ameiva quadrilineatus Cope, Proc. Acad. Nat. Sci. Philadelphia, 1862, p. 61; Bocourt, Mission Scientifique au Mexique et dans l'Amérique Centrale; Études sur les reptiles, livr. 4, 1874, pp. 259-260, pl. 20A, fig. 9 (preanal region of a Nicaraguan specimen); Boulenger, Catalogue of the lizards in the British Museum, 2nd Ed., vol. 2, 1885, pp. 347-348 (*part.*); Günther, Biologia Centrali-Americana Reptilia and Batrachia, 1885, p. 22 (*part.*); Dunn, Proc. Acad. Nat. Sci. Philadelphia, vol. 92, 1940, pp. 113-114.

Ameiva undulata quadrilineata Barbour and Noble, Bull. Mus. Comp. Zool. Harvard Col., vol. 59, no. 6, Oct. 1915, pp. 475-476.

Ameiva gabbiana, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1876 (1875), p. 118 (type locality, Old Harbour, Limón Prov. Costa Rica [now Puerto Viejo]).

Diagnosis: A small species of *Ameiva* reaching 74 mm. from snout to vent. A small posterior loreal segmented from the preocular separating latter from the labials; central gular scales relatively small; the scales on each side of this group continuing to maintain equal size to the subauricular swellings behind lower jaw; anterior loreal separated from first supraocular; eight rows of ventral scutes; three major rows of scutes under femur, the median smallest; a pair of well-differentiated postanals in males; usually less than 140 rows of granules about body. A pair of dorsal yellow lines separated by a broad darker stripe; a pair of lateral yellow lines bordering a broad dorsolateral blackish-brown stripe.

Description of species (From KUMNH No. 25648 San Isidro del General, San José Province): Part of rostral visible about four-fifths as long as the frontonasal; latter as broad as long, anterior nasals forming a suture about a third of the length of scale; prefrontal suture one third of the length of the scales; frontal much longer than wide, touching three supraoculars, not bordered anywhere by small granules; paired frontoparietals touching last supraocular; parietals slightly broader than long, separated by an interparietal smaller than parietal, but larger than a frontoparietal; four somewhat enlarged rows of scales follow parietals; three supraoculars, the second and third wider than long; six supraciliaries; about four large scales covering opaque part of eyelid; nostril in suture between nasals but cut largely from anterior, the first labial not forming a part of the labial border; suture between first labial and the rostral distinctly in advance of nostril; loreal large, as high as long, or slightly longer, not touching first supraocular, touching the third supralabial widely, the second only at a point; second loreal segmented from the preocular and separating it from the labials; presubocular touching one labial, subocular touching three labials; each of these three scales bordering orbit has a keel and these together form a continuous curving line; two postsuboculars larger than the two or three postoculars; a row of scales bordering orbit within the orbital series also enlarged somewhat; two or three rows of unequal sized temporals terminating forward in a much enlarged scale which might be regarded as the uppermost of the postocular series; seven (or eight) supralabials diminishing in size posteriorly, first with denticulate edge; about eight infralabials

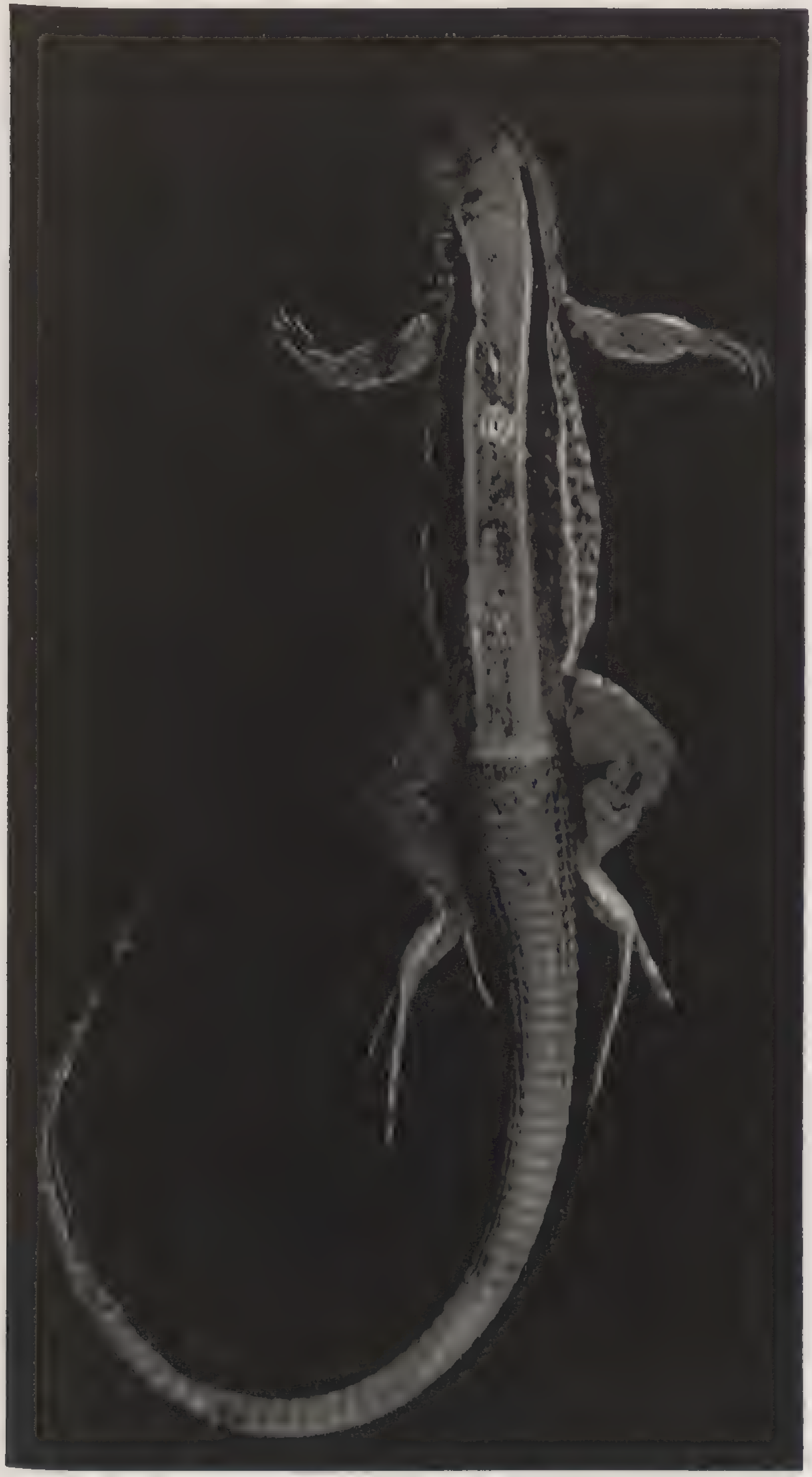

Fig. 68. *Ameiva quadrilineatus* Hallowell. KUMNH No. 25648; San Isidro del General, San José Province. Actual snout-to-vent length, 73 mm.

likewise diminishing in size; mental with a much larger labial border than the rostral; azygos postmental bordered by two labials; six pairs of chinshields, first pair completely in contact mesially, only this and second pair bordering directly on infralabials; about ten mesoptychial scales in a row on the neck increasing in size towards middle; about 30 transverse rows of scutes on ventral surfaces, in eight longitudinal rows; outer row equally as wide as adjoining row; about 140 rows of granules around body at middle; caudal scales elongate, rectangular, juxtaposed, strongly keeled (except under base of tail), scales forming transverse whorls; on lateral rows keels terminating in small spines or mucrones; preanal region with a pair of large scales near vent, preceded by three or four single scales diminishing in size, the lot surrounded by a row of slightly enlarged scales; femoral pores, 14-15; upper arm with a row of six enlarged scutes diminishing in size distally the innermost bordered proximally by five somewhat enlarged scales; four large scutes on back of upper arm with two or three much smaller scales touching them; two major rows of large scutes on forearm, the upper much the larger, the proximal part of series may be in three rows of smaller scales; three rows of scutes under femur, the median smallest; three rows under tibia, posterior smallest, somewhat irregular; subdigital scales single, except under joints, 27 under fourth toe.

Color in life: Above, head brownish the dorsum from occiput to base of tail with a broad stripe of brownish or olive brown, bordered on each side by a straight or very slightly sinuous line of yellow becoming yellowish green posteriorly, yellow lines separated by from 22 to 26 rows of granules; a few blackish flecks on the broad dorsal stripe; a broad dorsolateral stripe covering about 23 rows of granules is darker olive brown to blackish brown with indefinite darker spots more or less discernible, and bordered below by a yellowish line beginning at eye and terminating at groin.

Sides with numerous blackish-brown spots coalescing to form irregular vertical bars, separated by narrow irregular bars of olive. Arms and legs olive brown above with fleckings of darker color; front face of thigh with darker and lighter areas. Chin pinkish orange; venter greenish blue.

Measurements in mm.: Snout to vent, 73; tail 152 (complete); head length, 23.3; head width, 15; snout to ear, 19.2; snout to arm insertion, 29; axilla to groin, 33.2; arm, 28; leg, 51.

Variation: The species is represented in the collections mostly by western specimens. The following are present: San José Province: KUMNH Nos. 25643, 25647-25651, 34685-34689; San Isidro del General; 34690, El General; RCT. Nos. 3011-3013, 3016-3018, San Isidro del General. Puntarenas Province: No. 34691, Esquinas Forest Preserve, between Palmar and Golfito. Limón Province: No. 40578, Suretka.

A specimen from Suretka on the east coast—a gravid female 65 mm. snout to vent—has the dorsal stripe greenish olive, slightly darker on the edges and bordered by the yellow lines. The dark dorsolateral stripe is darker on the outer edges. Below this the lateral area is nearly unicolor with a lateral broken line of lighter color which parallels the lateral fold. The preanal series consists of a large nearly spherical scute preceded by two scales, the one adjoining not half as large, the anterior not one third of the size of second. There are 28 transverse rows of scutes and eight longitudinal rows of ventral scales. The outer mesoptychials are smaller, the inner larger than in the specimen described. The second loreal is fused to the presubocular, which separates the preocular from the labials, and the preocular is separated from the first supraciliary by a scale. There is a well-developed fourth supraocular, and a single small scute segmented from the inner edge of the second and third, separating the third supraocular from the frontal. There are 134 rows of granules about the middle of the body. The femoral pores are 15-14.

San Isidro specimens vary somewhat among themselves. The color pattern is maintained in all, the young being darker on back and sides but the ventral coloration differs between males and females. One specimen has a second presubocular present. In the preanal scutes, while the posterior is usually divided, two specimens show a single scale.

Genus CNEMIDOPHORUS Wagler

Cnemidophorus Wagler, Natürliches System der Amphibien, . . . 1830, p. 154 (type of genus *Cnemidophorus murinus,* designation by Fitzinger 1843).

Description of genus: Body generally covered with small smooth or conical granular juxtaposed tubercles on dorsum and sides; several series of enlarged ventral plates transversely arranged; head with large regular shields; tongue elongate, bifid, bilobate posteriorly not retractile into a sheath; tail rounded or basally somewhat quadrangular, covered with keeled regular scales on dorsal and lateral surfaces, forming transverse series; femoral pores present; two gular folds, the posteriormost distinct; eyelids present; ear-opening large with the tympanum somewhat sunken.

Two forms of the genus are of certain occurrence in Costa Rica; *Cnemidophorus deppii deppii* and *Cnemidophorus lemniscatus lemniscatus* Linnaeus. The validity of *Cnemidophorus alfaronis* Cope depends on the rediscovery of the form and ascertaining whether it is based on an anomalous series of characters or on normal characters.

Cope also described *Cnemidophorus amivoides* from La Carpintera, Cartago Province, Costa Rica. This has been referred to a species of *Ameiva.*

KEY TO COSTA RICAN SPECIES OF CNEMIDOPHORUS

1. Supraoculars normally three; three parietals; nostril in first nasal; black above, with seven dorsal cream lines; on side a broad stripe of rusty brown or brick red divided medially by a longitudinal cream line; legs dotted . . . . *deppii deppii*
   Supraoculars normally four 2
2. Normally three parietals; nostril in first nasal; three labials touch loreal; nine lines on body the ground color between them black or greenish gray; below greenish white; legs with four irregular longitudinal lines . . . . *alfaronis*
   Normally five parietals; nostril between two nasals; color and marking variable . . . . *lemniscatus lemniscatus*

Cnemidophorus alfaronis Cope

Cnemidophorus alfaronis Cope, Proc. Acad. Nat. Sci. Philadelphia, 1894, pp. 199-200 (type locality San Mateo Alajuela Province, Costa Rica; type in AMNH No. 16315 A. Alfaro, Coll.)

Cnemidophorus deppii deppii Burt, U. S. Nat. Mus. Bull. 154, 1931, pp. 56-63 (*part.*) (Puntarenas Province, Tivives).

Diagnosis: Abdominal plates in eight rows; 19 femoral pores; about 12 preanal plates in a triangular patch; four supraorbital plates normally.

Description of species (From type description):

"Allied to *C. deppei.* Nostril entirely in nasal plate; first loreal bordering first three labials; second loreal higher than long. Supraorbital plates four on one side, and five on the other, the first quite small, the third and fourth broader than long. Interparietals and the single parietals, longer than the frontoparietals. Infralabials eight; median gulars enlarged all the way across, graded; scales of mesoptychium large, in two or three rows, no granules on the border. Abdominal plates in eight rows; large brachials in six rows, continuous with brachials; no postantebrachials. Six rows of femorals at middle. Femoral pores nineteen. Preanal plates about a dozen in a triangular patch continuous with the ventrals. Extended hind foot reaches the orbit.

"Four white lines on each side, and a vertebral line. Spaces between first and second, and dorsally between fourths of opposite side, greenish gray; space between second and fourth, black. Head paler; below greenish-white. Posterior limbs with four irregular longitudinal lines; one anterior, two superior, and one posterior.

"Total length, 170 mm.; length to vent, 55 mm.; do. to collar, 19 mm.; length of fore limb, 20 mm.; do. of hind limb, 41 mm.; do. of hind foot, 23 mm."

"This species resembles in general appearance the *C. deppei deppei* (*sic*) but the scutelation is materially different. An important character is the presence of four supraorbital plates, from the last of which a fifth may be cut off. The parietals and interparietals are also relatively longer than in that species.

"No. 216 San Mateo; found by Sen. Anastasio Alfaro, Director of the Museo Nacional, to whom the species is dedicated."

I have seen no specimens conforming to this description. The character of the preanal scales, of the supraorbitals, and of the parietals, together with differences in color and markings strongly suggest a population worthy of recognition. It has been suggested that these presumed differential characters are anomalous but this is not proved.

Cnemidophorus deppii deppii Wiegmann

(Fig. 69)

Cnemidophorus deppii Wiegmann, Herpetologia Mexicana, 1834, p. 29 (type locality restricted to Tehuantepec, Oaxaca, Mexico by Smith and Taylor); Bocourt, Mission Scientifique au Mexique et dans l'Amérique Centrale; Études sur les reptiles, livr. 3, 1874, p. 281, pl. 20c, fig. 5, pl. 20d, fig. 1; Günther, Biologia Centrali-Americana; Reptiles and Batrachians, 1885 Aug. p. 27 (*part.*); Boulenger, Catalogue of the lizards in the British Museum vol. 2, 1885 p. 371 (*part.*).

Cnemidophorus deppii deppii Burt, U. S. Nat. Mus. Bull. no. 156, 1931, pp. 56-63 (*part.*); Smith and Taylor, U. S. Nat. Mus. Bull. no. 199, 1950, pp. 178-179.

Diagnosis: Both sexes with dorsum black traversed by seven cream lines; sides with a broad brick-red stripe divided by a longitudinal cream line; venter anteriorly with six rows, posteriorly with eight rows of ventral plates, the outer row smaller than the others; first pair of chinshields forming a suture their entire length; scales bordering nuchal collar enlarged in about three rows; femoral pores 16-20; nostril entirely in nasal; three supraoculars.

Description of species (From KUMNH No. 40577 ♂ one to two miles north of Hda. Santa Rosa, Guanacaste, Costa Rica): Body moderately slender; (no strong sexual dimorphism in size or markings); part of rostral visible above a little less than length of nasal; nostril completely in nasal, the mutual nasal suture about a third

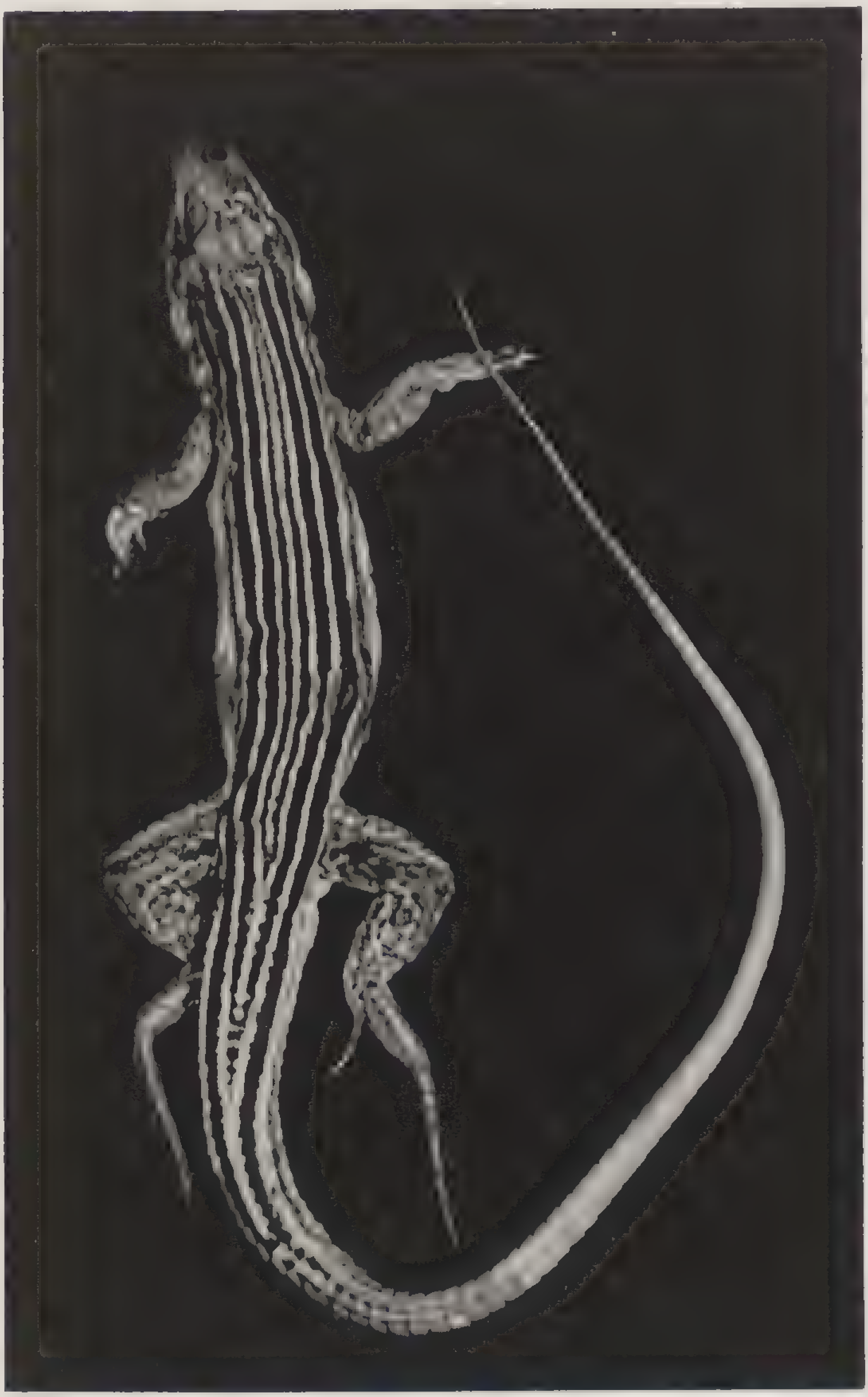

FIG. 69. *Cnemidophorus deppei deppei* Wiegmann. KUMNH No. 40986; near Santa Rosa, Guanacaste; actual length, snout to vent, 70 mm.; total length, 232 mm.

of their length; frontonasal somewhat rounded anteriorly, slightly longer than wide; prefrontals equal in length to the frontonasal, narrower than mutual suture, slightly greater than half their length; frontal longer than wide; a pair of frontoparietals, parietals, and an interparietal, the last not extending quite as far forward as the parietals; the parietals are followed by three rows of somewhat enlarged irregular scales (occipitals).

A postnasal about as large as the nasal followed by a very large loreal that is higher and more than double the length of the postnasal, and like it touching two supralabials; preocular vertically elongate, slender, traversed in its upper part by a curving keel; one presubocular also with a keel, preceding the elongate subocular also with a keel near its upper edge; the postocular series consists of five scales, irregular in size, the lower two largest; temporal area with a double row of larger scales on its upper border continuous with a row touching postoculars; a few somewhat enlarged scales preceding tympanum, and extending above angle of jaw; three supraoculars all in contact with the frontal, the two posterior separated from the supraciliaries by a row of five granules; five supraciliaries the first more than half length of second; lower eyelid with five unequally enlarged scales somewhat elongate, hexagonal; seven or eight supralabials the edge of first denticulate; six infralabials, the angle of the mouth bordered by numerous granules; mental large, with a labial border exceeding that of rostral; a large azygos postmental touching two infralabials, the first being very small; first pair of chinshields forming a common suture their entire length, and also touching the second and third labials; following five pairs of chinshields separated from labials by scales or granules, and separated from their fellows by granular scales; throat with a transverse area of somewhat larger scales, extending from cheek to cheek; a slight fold precedes the gular fold which is bordered by about three irregular rows of somewhat enlarged mesoptychial scales.

Dorsal and lateral part of body covered with small tubercular or conical granules, juxtaposed, and forming fairly regular rows; six rows of enlarged transverse plates on breast and on anterior part of venter, the median rows smaller than adjoining rows; posteriorly eight rows, the outer added row smaller than the adjoining row; this row is anticipated anteriorly by scales only a little larger than surrounding granules. Tail surrounded by enlarged caudals distinctly keeled dorsally and forming transverse rows, with an indistinct lateral depression on base; tail somewhat quadrangular in cross-section at base.

Arm moderately short, covered with granules on under surface; upper arm covered with irregularly sized scales, largest on anterior face; forearm with somewhat larger granules on the posterior and part of upper face; remainder with three series of large scutes, the posterior row much widened; fingers with undivided lamellae below; a group of three enlarged scales on posterior part of palm, claws long, slender.

Legs granular on posterior part of thigh and tibia the granules extending onto the dorsal surface of the latter; front and ventral part of thigh covered with large scutes of irregular sizes; under surface of tibia with large scutes; toes with single or paired lamellae or scales on undersurface, 27-30 in number; preanals arranged as follows: a pair preceding vent, followed by a large single scale; this preceded by a smaller pair; the whole series bordered on sides by an irregular row of moderately enlarged scales; femoral pores, 16-17, separated mesially by four scales.

Color in life: Head brownish, uniform; body above deep black, the black bordered laterally by a cream line extending onto tail where it widens somewhat and becomes conspicuous for a fourth of tail length; remainder of black surface traversed by five narrow cream- or bluish-white lines. The two outer extending onto tail for about a fourth of its length, the next two (pair) fuse into a single line above vent which continues on middle of base of tail; median line terminates between the leg insertions; a broad brick-red stripe from head to groin, bisected by a longitudinal cream line on middle of side; throat cream-white; venter bluish with some milk-white lateral flecks on outer row of ventral scutes; pinkish cream under limbs and under tail, the pinkish scarcely indicated. Legs, to a lesser extent, arms also with small light tan dots and on back of thigh a broken cream line.

Measurements in mm.: Snout to vent, 70; tail, 165; length of head, 20.6; width of head, 12; snout to ear, 17.2; snout to arm insertion, 28; axilla to groin, 34; arm, 22; leg, 50.

Variation: Cope has described a form from Costa Rica as *C. alfaronis* which was distinguished by having the following characters that differ from this species. First loreal (postnasal) touching three labials; supraoculars, four on one side, five on another, first quite small the third and fourth broader than long; he makes no mention of the broad reddish lateral stripe.

Alfaronis has been placed in the synonymy of *C. deppii deppii* by certain authors but I am not certain that it should remain there.

Cnemidophorus lemniscatus lemniscatus Linnaeus

Lacerta lemniscata Linnaeus, Systema Naturae ed. 10, vol. 1, p. 209 (type locality "Guinea" = Guiana, South America); Burt, U. S. Nat. Mus. Bull. 154, 1931, pp. 30-40.

While this species has not been reported from Costa Rica, presumably acceptable records are available of the occurrence of this form in Honduras, Guatemala, Nicaragua, Panamá and Colombia. One must conclude that it most likely also occurs in Costa Rica. Burt (*loc. cit.*), shows its presence in Costa Rica in his distributional map, fig. 11.

Burt has placed several names in synonymy and it may be that a different subspecific name is applicable. In the absence of specimens I present data largely from Burt (*loc. cit.*).

Diagnosis: Normally five parietals; nostril usually in suture between nasal plates; femoral pores variable 15-29. Ventral plates, eight series; supraoculars normally four, rarely three; femora of young spotted, of adults spotted or unspotted; young with six to ten stripes (usually nine); lines present or absent in adult, and if present lateral stripes distinct or faded, or absent, the sides spotted or unspotted. Venter white to blue, lower flanks usually brilliant blue or reddish brown.

Description: "Snout rather blunt to moderately pointed; nostril usually in suture between anterior and posterior nasal plates; anterior nasal not in contact with second upper labial; supraoculars normally 4; supraocular granules usually extending forward to the middle of the third supraocular; frontoparietals normally 2; parietals normally 5; anterior and posterior gulars usually poorly differentiated, rather small, often uniform or slightly enlarged centrally or medio-laterally; mesoptychials moderately large, largest medio-laterally or at a point just to the side of the median line, smaller towards the sides, in 1-6 rows, posterior often largest; post-mesoptychial granules minute, sometimes extending forward over the edge of the posterior gular fold. It has been observed that smaller mesoptychial scales occur in specimens in lower more sandy areas, and that larger ones appear in those collected at higher more brushy or rocky elevations."

"Body elongate, ventral plates in 8 longitudinal and 27-36 transverse rows; anal spurs often well developed; dorsal granules small; limbs well developed; brachials 3-8; antebrachials 2-4; brachials usually continuous with antebrachials at a point of contact; postantebrachials granular or slightly enlarged; postbrachials small undifferentiated; femorals 4-7, tibials 2-4, femoral pores 15-29; tail elongate, tapering with rather strong continuous longitudinal keels; ventral caudals usually ridged and with more or less definite longitudinal keels."

Color: Coloration moderately variable; lower surfaces white to bright blue; lower flanks blue, gray, dusky, brown, greenish or olivaceous; tail white to slaty below, bright blue in young and sometimes even in the adult, often olivaceous above; femora usually spotted or reticulated with white, but sometimes unicolor; dorsal ground color brownish, olivaceous gray bluish or black; young with from 6 to 10 light stripes, usually with 9; adults lined or without lines, spotted or unspotted; if no lines are present, there may be a more or less distinct dark dorso-lateral streak or band, above which the ground color is essentially bluish or olivaceous.

In a few of the smaller specimens which possess an even number of stripes, particularly from Honduras and northwestern Brazil, a widened yellowish middorsal streak is present as in *sexlineatus*.

Measurements in mm.: (916 specimens) Length snout to vent, 31-104; tail, 78-226; total 109-330.

Remarks: This species probably occurs in the eastern or northern Caribbean drainage areas in the lowlands.

FAMILY SCINCIDAE Gray

Scincidae Gray, Ann. Phil., vol. 26, 1825, p. 201 (*part.*).

The family Scincidae is represented in the Western Hemisphere by only five of its numerous genera, three of which are known to occur in Costa Rica.

The members of two genera, *Mabuya* and *Eumeces*, are largely rivals wherever they occur. At various places one genus gains ascendency over the other. Thus in China and most of eastern Asia, *Eumeces* tends to have numerous species to the near exclusion of *Mabuya*. In south Asia, *Mabuya* almost completely excludes *Eumeces*—there being no species of this genus known from Thailand to Persia. In North Africa, *Mabuya* tends to be excluded. In the United States where there are numerous species of *Eumeces*, *Mabuya* does not occur; but in Mexico one species does occur and where it is present it may occur to the exclusion of *Eumeces* or may be a competitor. Farther south in Panamá and South America—

also in South Africa—*Mabuya* becomes dominant and *Eumeces* is excluded.

Not only is *Eumeces* seemingly affected by the presence of the genus *Mabuya*. In areas where the numerous genera of the Scincidae are becoming subterrestrial, losing their limbs and lengthening their bodies, we usually find several aggressive species of *Mabuya*. This is exemplified in India, South Asia, Indonesia and the Philippines. And it may well be that the genus represents the chief competitor with these groups, and only those species that seek food in other habitats and become burrowing or enter niches where *Mabuya* cannot follow, are able to survive.

KEY TO THE GENERA OF COSTA RICAN SCINCIDAE

1. Supranasals absent; smaller size, the snout-to-vent length not known to exceed 65 mm.; frontoparietal single; no undivided transparent disc on eyelid in Costa Rican forms .... *Leiolopisma*
   Supranasals present; size larger, reaching 125 mm. snout to vent; double frontoparietals 2
2. Palatine bones not meeting on middle line of palate......... *Eumeces*
   Palatine bones meeting and overlapping on the middle line of palate, *Mabuya*

Leiolopisma Duméril and Bibron

Leiolopisma Duméril and Bibron, Erpétologie Générale, vol. 5, p. 742 (type of genus *Scincus telfairii* Desjardins, by monotypy; proposed as a subgenus).

Description of genus: Body generally smooth, the limbs well developed; lower eyelid with or without an individual transparent disc, the disc not present in the recognized Costa Rican species; nostril pierced in a single nasal; no supranasals; tympanum distinct; rostral in contact with the frontonasal; nuchals present or absent; (absent in Costa Rican specimens); frontoparietal single or double (single in Costa Rican forms); no pterygoid teeth.

The genus is widespread throughout the eastern United States, Mexico and Central America probably not extending south much beyond Panamá. One species is recognized in Costa Rica, occurring on both the Caribbean and Pacific drainage areas. There is divided opinion as to the generic placement of the scincs here considered. I am of the opinion that recognition of the genus *Leiolopisma* under the supergenus *Lygosoma* is the wisest course. That *Leiolopisma* might profitably be divided into subgenera is quite probable. Mittleman's proposal of the genus *Scincella* for the American forms (type, *Leiolopisma laterale*) cannot apply here since the species occurring in Costa Rica differs from the type of the genus in four characters that are usually regarded of generic or at least subgeneric significance. These are: (1) the absence of nuchal scales; (2) the presence of an undivided frontoparietal; (3) the absence of an undivided transparent (or opaque) disc on the lower eyelid; (4) no pterygoid teeth. As regards to the fourth character it is possible that pterygoid teeth may be absent in certain species placed in *Scincella.*

It would appear then that *Leiolopisma cherriei* may not be as closely related to other American leiolopismids as presumed by previous authors and may well merit a generic or subgeneric designation of its own, since the absence of the typical undivided palpebral disc would seem to preclude its association with *Leiolopisma* itself. It is probable that the name *Lampropholis* is available but at the moment I cannot verify this.

Leiolopisma cherriei Cope

There are two forms of this species known to occur in Costa Rica, one the typical *Leiolopisma cherriei cherriei* Cope, described from the southwestern part of the country, the other undescribed occurring chiefly in the northern and eastern parts of the country. They may be distinguished by the following key:

KEY TO COSTA RICAN SUBSPECIES OF LEIOLOPISMA CHERRIEI

Primary temporal normally single, or if not, lower scale much larger than upper, touching upper secondary temporal; upper secondary temporal larger; scale rows 30-34 usually 32. (80%) . . . . . . *cherriei cherriei* Cope

Two primary temporals the upper equal to or but little smaller than lower, the only upper touching upper secondary temporal; upper secondary temporal smaller; scale rows 30-32 usually 32. (56%), *cherriei lampropholis* subsp. nov.

Leiolopisma cherriei stuarti is said to differ from *cherriei cherriei* in having a lower average count of dorsal scales (59-67, average 63.2) while in *cherriei* the scales vary from 65-72 the average being 69. It likewise has a single anterior temporal. *L. cherriei cherriei* is a larger subspecies than *cherriei stuarti,* reaching a length of 68 mm. from snout to vent.

Leiolopisma cherriei cherriei Cope

(Fig. 70)

Mocoa cherriei Cope, Proc. Amer. Philos. Soc., vol. 31, 1893, pp. 340-341 (type locality, Palmar, Puntarenas Province, Costa Rica, G. K. Cherrie, Coll.).

Lygosoma assatum cherriei Stuart, Occ. Papers Mus. Zool. Univ. Michigan, no. 421, 1940, pp. 13-14.

Lygosoma cherriei Smith, Proc. Biol. Soc. Washington, vol. 52, Dec. 15, 1939, pp. 191-193, pl. 7, fig. 2 (*part.*) (reports a series of specimens as of this species from Potrero Viejo and Cuautlapan, central Veracruz, Mexico, on the authority of L. D. Stuart).

?*Lygosoma cherriei stuarti* Smith, Proc. Biol. Soc. Washington, vol. 54, Dec. 8, 1941, pp. 181-182 (same material used in preceding paper, together with four other paratypes).
Leiolopisma cherriei cherriei Smith, Herpetologica, vol. 3, 1946, pp. 110-111.
Scincella cherriei cherriei Mittleman, Herpetologica, vol. 6, 1950, p. 20; Smith, in Smith and Taylor, U. S. Nat. Mus. Bull. 199, p. 157.
?*Lygosoma cherriei cherriei* Mertens, Abh. Senckenb. Naturf. Ges., no. 487, 1952, p. 58 (Dept. Chalatenango, El Salvador).

Diagnosis: A single frontoparietal much larger than frontal; interparietal small, enclosed normally by parietals; no nuchals; no undivided transparent disc in lower eyelid; frontonasal normally in contact with frontal; a single large anterior temporal normally (rarely a small upper scale segmented off); scales from occiput to above vent, 64 to 70, the lower numbers usually males, the higher females; usually 32 scales about body (80%) (rarely 30 or 34).

Description of species (From KUMNH No. 34501 Esquinas Forest Reserve near Palmar, Puntarenas Province, C. R.): Rostral more than twice as wide as high the part visible above approximately the length of the frontonasal; latter not quite twice as wide as long; prefrontals widely separated, thus leaving frontonasal and frontal broadly in contact; four supraoculars the last three touching the frontoparietal; two anterior touching frontal; interparietal small enclosed behind by large parietals; nasal single the nostril behind vertical level of the rostro-supralabial suture; first loreal only slightly narrower than second and but a little higher; two superimposed preoculars; two presuboculars in front of the subocular supralabial (5th); four of the ocular series touch this scale; four postsuboculars and postoculars; eight supraciliaries; seven supra-

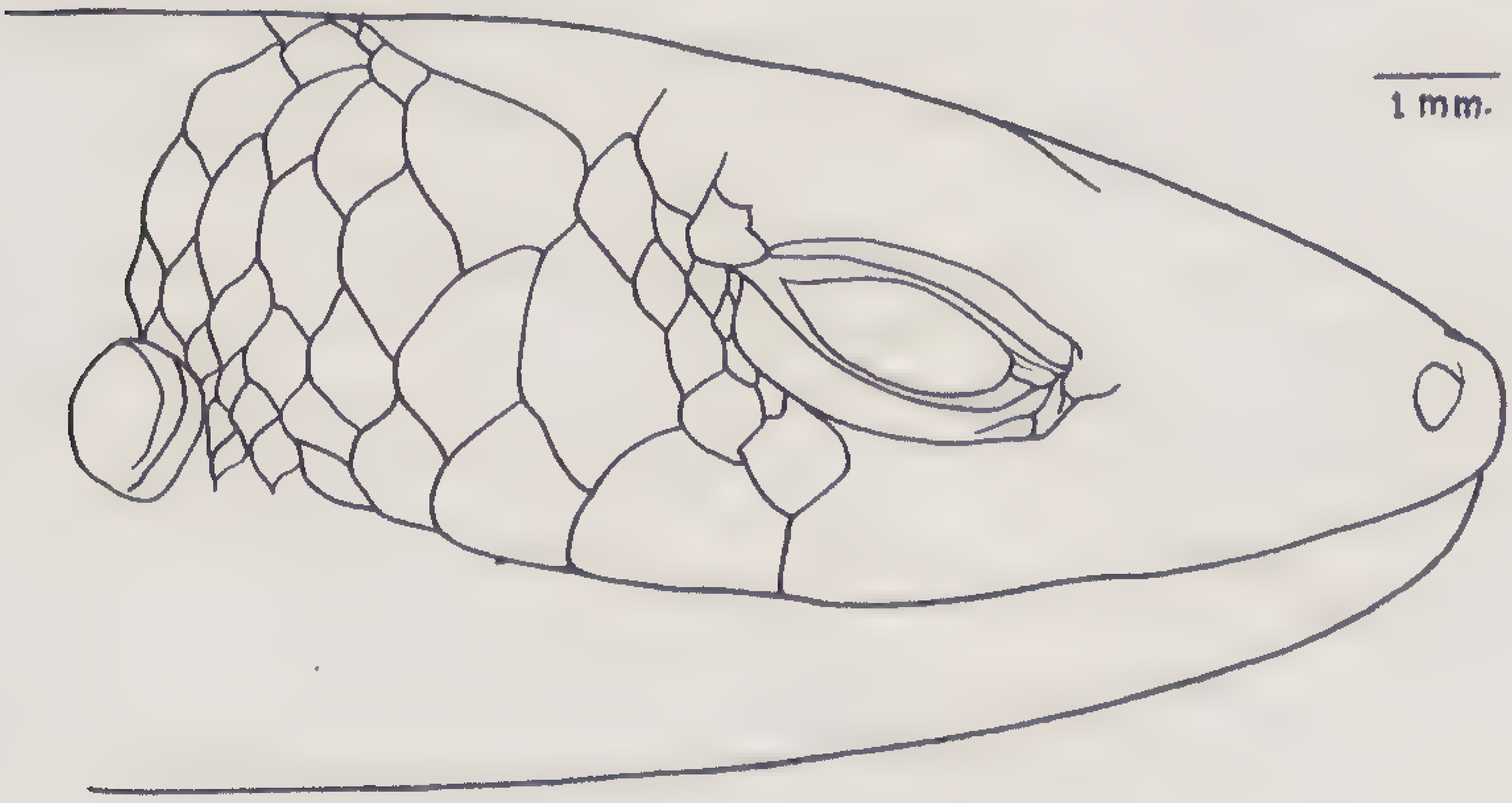

FIG. 70. *Leiolopisma cherriei cherriei* Cope. Temporal scales of KUMNH No. 34501; actual length, snout to vent, 58 mm. Esquinas Forest Reserve (between Palmar and Golfito), Puntarenas Province.

labials the sixth a little larger than the fifth; mental border on lip a little greater than that of rostral; an azygos postmental; six infralabials the first small; three pairs of chinshields, the first in contact mesially, the second pair separated by one scale, the third pair separated by three scales; postgenials not differentiated significantly.

A single large anterior temporal separated from the parietal by a small scale; a pair of large secondary temporals, third temporal series of five scales; eye with lids, the lower eyelid somewhat opaque with a group of larger scales; tympanum large, in size nearly equal to eye-opening, rather deeply sunk. Arm and leg moderately developed, when adpressed the digits overlap about two and one-half millimeters; 12 lamellae under two longest fingers; 18-19 under longest toes; tail circular or slightly compressed; subcaudals, 121; tail partly regenerated, the regenerated subcaudals widened.

Color in life: Dorsum brown with very numerous tiny blackish marks giving the back a nearly uniform appearance; tail with very indistinct darker transverse lines; a black stripe from nostril to eye continuing across palpebral scales of eyes, widening behind eye, covering most of three scalerows then passing above the ear-opening to some distance on side, where it becomes diffuse; a whitish or cream line below eye passes along side of neck above arm and is lost on side; chin and venter yellowish; tail yellowish below, becoming grayish toward end.

Measurements in mm.: Snout to vent, 57; tail, 96; length of head, 13; width of head, 8.6; snout to ear, 11.6; snout to arm insertion, 21; axilla to groin, 31; arm, 14; leg, 19.

Variation: The following specimens from southwestern Costa Rica are in the collection: Puntarenas Province: KUMNH Nos. 34486-34494, Golfito; 34501, Esquinas; 34496-34500, Palmar (topotypes); 34440-55, 34496-34501, 15 mi. WSW San Isidro del General. San José Province: No. 34440-41, San Isidro del General.

All the specimens from Palmar and Esquinas have a single anterior temporal. Certain of the specimens from Golfito (elevation nearly at sea level) have the large anterior temporal segmented leaving a large lower scale and a smaller upper scale. In the series from WSW of San Isidro at an elevation of about 800-1000 ft., 12 have the single anterior temporals while three have a large lower with a small scale segmented from its top.

At least five of these specimens reach a snout-vent length of 61 mm., the largest being a little more than 68 mm. Thirty-two scales is the normal number surrounding the middle of the body, occurring in approximately 80 percent of the individuals; 13.3 percent have 30 scales and 6.6 percent have 34 scales.

The sides of the body often have numerous bluish-white, rounded dots. These are only moderately conspicuous in preserved material. The number of scales between occiput and a point above vent varies between 65-72 the average being about 68 (69 according to H. M. Smith *loc. cit.* 1939, 1941).

*Leiolopisma cherriei lampropholis** subsp. nov.

(Figs. 71, 72)

Type: KUMNH No. 34436, Bataan, Limón Province; collected July 23-25, 1951, by Edward H. Taylor.

Paratypes: KUMNH No. 34409-14, Los Diamantes; 34415-34435, 34437-34439, Bataan (topotypes); 34470-34485, La Lola; 40514-40516, Suretka; all from Limón Province; 40521, Puerto Viejo, Heredia Province; 25169, 25524-25542; 34456-34469, 34502-34510, 34511-34539, 34864; R. C. T. Nos. 267, 271, 273, 275, 276, Turrialba and environs, Cartago Province.

It is most probable that Cope's report of *Mocoa assata* (Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1876 [1875], p. 179 from Old Harbour [= Puerto Viejo], Limón Province) should be referred to this subspecies.

Diagnosis: Frontoparietal large, single; tympanum large, much depressed, without lobules; normally two anterior temporals; no nuchals; no undivided transparent disc on eyelid.

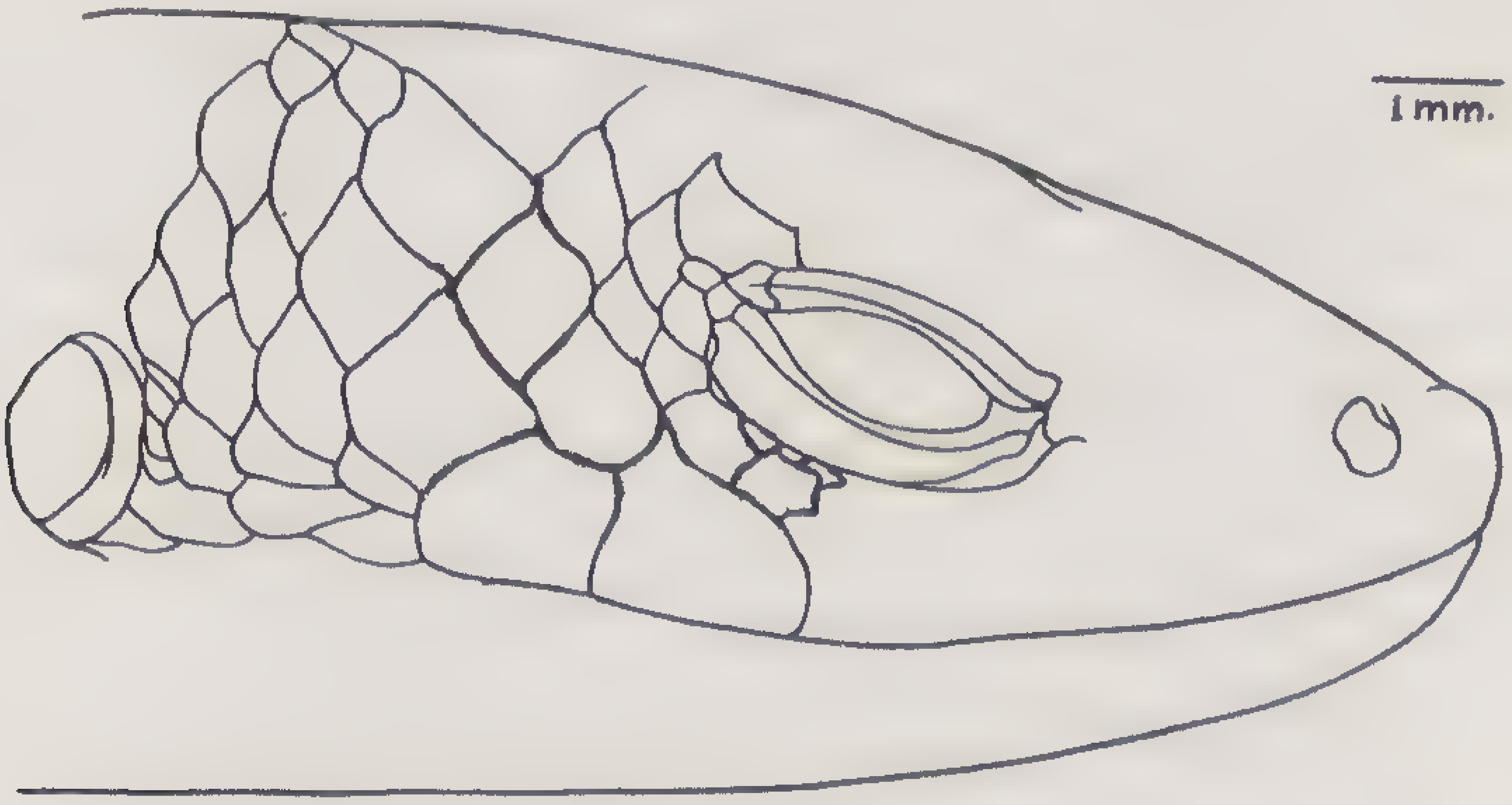

FIG. 71. *Leiolopisma cherriei lampropholis* subsp. nov. Usual arrangement of the temporal scales.

Description of type: Snout bluntly pointed; rostral much wider than high, forming a curving suture with the frontonasal; latter broader than long, touching nasal and first loreal, forming a suture with frontal, separating prefrontals; frontal rather narrow, much narrower than the supraorbital region, longer (one and one-third times) than its distance from tip of snout; five supraoculars, the last small, first longest, touching the prefrontal; frontoparietal single as long as frontal but much larger, bordered by three supraoculars; interparietal small, notching the frontoparietal behind, enclosed by the parietals; latter scales diagonal, bordered behind by an upper secondary and a tertiary temporal and three or four body scales; no specialized nuchal scales present.

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* From Greek word lampros = shining, bright and the Greek word pholis = scale.

Nostril in single nasal that touches one supralabial; first loreal higher, but narrower than second, which is wider at top than bottom (the second loreal in this specimen abnormal), followed by a superimposed pair of preoculars; two presuboculars; three suboculars, the median smallest; two or three postsuboculars; nine supraciliaries in direct contact with the palpebrals of the extremely narrow upper eyelid; a pair of anterior temporals; three secondary temporals, seven supralabials, the last separated from tympanum by three or four paired scales; tympanum large, rounded, rather deeply sunk; mental border on lip equal to, or a little greater than, rostral border; a large postmental touching two infralabials; eight infralabials; three pairs of chinshields, only first pair in contact; lower eyelid with a row of opaque scales, the three median largest; no transparent disc.

Arms and legs moderately developed, pentadactyl. When limbs are adpressed they overlap one or two millimeters; seventeen soft unkeeled lamellae under fourth toe. Body scales generally smooth, but those on sides of neck and anterior part of body show two to five minute tubercular keels near their posterior border; scales generally somewhat rounded behind; around neck, 33 scalerows; around middle of body 30 rows; a pair of enlarged preanal scales; about 114 subcaudals, counting from vent; (scales on dorsal surface of gravid females often appear larger since the skin is stretched somewhat and each dorsal scale covers less of the adjoining scales).

Color in life: Above on head and body dark brown, the eight dorsal scalerows nearly uniform; an irregular dark stripe behind eye through upper edge of ear along side of neck where it is more or less broken up, with only fine scattered darker spots on sides, and a few somewhat dim light dots smaller than a scale; rather olive brown on dorsal part of tail, the sides flecked with darker; there is a faint suggestion of transverse lighter lines across body and tail; venter, under limbs, and base of tail immaculate yellowish; under tail faintly bluish with a scattering of darker pigment; below

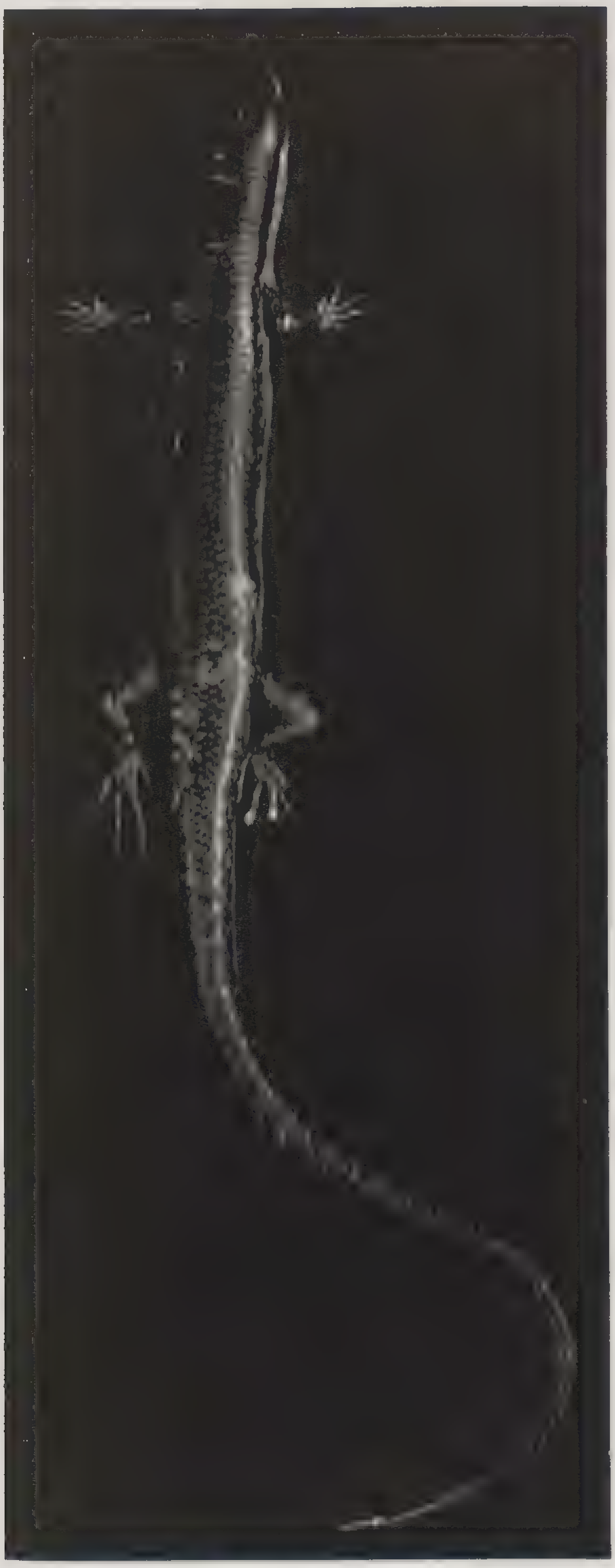

Fig. 72. *Leiolopisma cherriei lampropholis* subsp. nov. KUMNH No. 34433. Type. Bataan, Limón Province, C. R.; actual total length, 148 mm.

the dark stripe on head, an irregular light line to shoulder; spots between eye and nostril; black spots below eye and on sutures between supra- and infralabials; side of head and neck light with black flecks and a short dark line from jaw angle below tympanum; under surface of hands and feet dark; limbs brown with tiny black flecks.

Measurements in mm., of Leiolopisma cherriei lampropholis subsp. nov.

Number	34436	34421	34479	34478
Locality	Bataan	Bataan	La Lola	La Lola
Total length	148	134	133.5	128
Snout to vent	57	55	50	49
Tail	91	78	83.5	79
Snout to arm	20	20	18.8	18.2
Axilla to groin	28	28.2	26	25
Width of head	8	8.1	7	6.8
Length of head	12.6	12.2	11.2	11
Arm, length	13.5	13	9.5	10.5
Leg, length	18	19	17	17

Variation: The material available of the eastern form is extensive. The following series are available: Limón Province: KUMNH No. 34409-14, Los Diamantes; 34415-39, Bataan; 34470-85, La Lola; 40514-16, Suretka. Heredia Province: No. 40521, Puerto Viejo. Cartago Province: 25169, 25524-42, 34456-69, 34502-34510, 34511-34539, 34864, Turrialba and environs. The following specimens are also being referred, at least temporarily, to this form: Guanacaste Province: KUMNH Nos. 40512-13, 40518-20, 40522-24, four to five km ENE Tilarán.

The chief point of distinction between this form and *cherriei cherriei* is the presence of two superimposed primary temporals lying somewhat diagonally and separated from the parietal by a small scale, the last of postocular series; primaries followed by three secondary temporals, the upper touching the parietal and usually a little larger than the others; these are bounded behind by five subequal scales extending from the parietal to the last labial in a curving series.

The legs of the young are proportionally longer than in adults so that they may overlap, when adpressed, four or five millimeters.

In adult males the legs overlap one or two millimeters; but in very large especially gravid females the legs may fail to touch by one or two millimeters.

In most of the eastern specimens there are three presuboculars (following the two preoculars) anterior to the fifth supralabials; latter touches three suboculars; there are two scales following the supraocular series, the first might be called a small fifth supraocular, but it lies posterior to the last supraciliary. There are but two enlarged preanals, the two scales adjoining these on the sides are small and narrow; there are approximately 116 subcaudals; when the tail is regenerated the subcaudals become much widened. The number of scalerows varies from 30 to 32, the percentages are: 56.2 percent with 32; 37.5 percent with 30; 6.3 percent with 31. Counts were made on 80 specimens. The number of transverse dorsal scalerows are usually two to five higher in females than in males. The range in both sexes is from 62 to 69, the average being near 66. Normally the first loreal (postnasal) is narrower than the second, higher and tending to curve forward slightly. The second loreal is wider at top than bottom. However they are variable, often one or the other being excluded from the supralabials. I have seen only one specimen with the prefrontals touching and a single specimen with the parietals separated.

Color variation is somewhat a matter of age. Adults are generally brown above with black and dull cream or tan markings. The chin is creamy white. The breast and abdomen are yellow; an area behind the vent may be salmon or yellowish. The under surface of the tail is gray. In the young the tail is bluish or bluish black, but this color is lost rather early in life. On the underside of the legs there is often a shade of pink.

Genus EUMECES Wiegmann

Eumeces Wiegmann, Herpetologia Mexicana, seu descriptio amphibiorum Novae Hispaniae. Berolini, 1834, p. 36 (type of genus not designated. He included *Scincus pavimentatus* Geoffroy, *Scincus rufescens* Merrem, and *Scincus punctatus* Schneider); *idem* Archiv. für Naturg., vol. 2, 1835, p. 228 (here he removes *Scincus rufescens* and *S. punctatus* from the genus, since they had been included through error, leaving only a single species *Scincus pavimentatus* which becomes the type of the genus by monotypy); Taylor, Univ. Kansas Sci. Bull., vol. 23, Aug. 15, 1936, pp. 29-48.

Description of the genus: Maxillary and mandibular teeth pleurodont, the crowns conical or somewhat rounded; pterygoid teeth; palatine bones not meeting on the median plane of the palate, varying in degree of proximity; eyelids well developed; a pair of supranasals; four supraoculars; prefrontals, frontoparietal and interparietal distinct. Limbs well developed, pentadactyl, clawed. Body scales cycloid, underlaid by bony plates; no femoral pores.

This genus is cosmopolitan occurring in both Asia and Africa. In the Western Hemisphere the genus occurs from Canada throughout most of the United States and Mexico, represented by many species. The number of species dwindles until only three are known south of the Isthmus of Tehuantepec. Two of these occur in northern Central America, *Eumeces schwartzi* having been taken in northern Guatemala and *E. sumichrasti* in northern Honduras. The third, *Eumeces managuae*, a species originally discovered in Managua, Nicaragua, is here traced south into Costa Rica and presumably is the only known species of the genus occurring there. Four specimens were taken.

Eumeces managuae Dunn

(Fig. 73)

Eumeces taeniolatus (non Blyth) Boulenger, Catalogue of the lizards in the British Museum, vol. 3, 1887, p. 383, locality (*in errore*) "Punjab, India".
Eumeces managuae Dunn, Proc. Biol. Soc. Washington, vol. 46, 1933, p. 67, 68 (type locality, aviation field, Managua, Nicaragua); Taylor, Univ. Kansas Sci. Bull., vol. 23, pp. 104-110, pl. 3, figs. 6, 7, 8; Univ. Kansas Sci. Bull., vol. 37, pt. 1, 1955, pp. 531-534, fig. 11.

Diagnosis: A large species of the genus characterized by a greatly expanded series of median dorsal scutes extending from the nuchals to the base of the tail; four pairs of expanded nuchals, one postmental, a postnasal; large auricular lobules; subcaudals transversely widened; adpressed limbs widely separated, variegated gray or gray-brown above the dark color tending to form elongate lines.

Description of species (From KUMNH No. 34185, Tenorio, Guanacaste, Costa Rica): Rostral large, much wider than high, the part visible above forming a very obtuse angle, its length less than that of the supranasals; latter moderate, broader than long, the length of the median suture distinctly less than the greatest length of the scale, which is less than its width; the nasal is definitely divided; frontonasal much larger than the prefrontals, wider than long, forming a suture with the frontal and at same time separating the prefrontals; latter generally pentagonal, touching two loreals laterally, and touching the frontonasal, frontal, first supraocular and first supraciliary; frontal angular anteriorly reaching its greatest width between the first supraoculars, and then narrowing slightly posteriorly, bounded laterally by two supraoculars and behind by the paired frontoparietals, and not making a suture with the interparietal (as in the type). Interparietals a little smaller than the

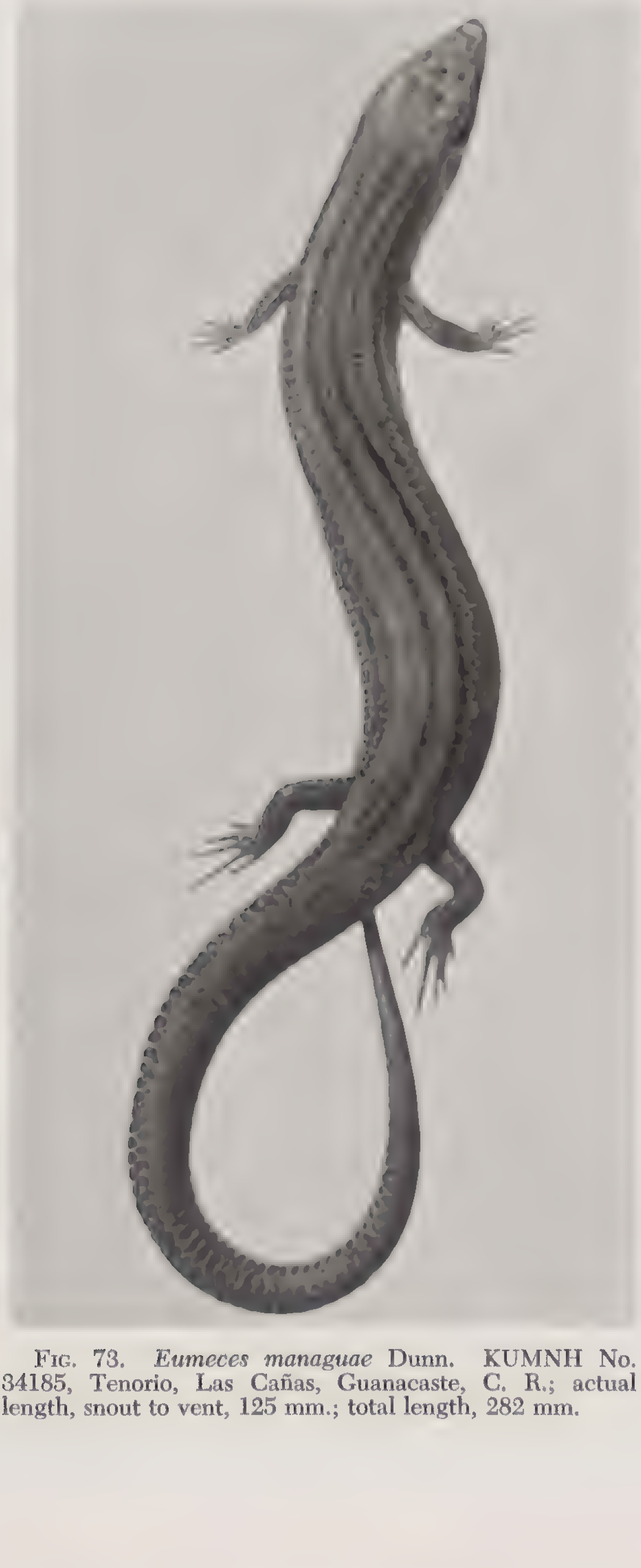

FIG. 73. *Eumeces managuae* Dunn. KUMNH No. 34185, Tenorio, Las Cañas, Guanacaste, C. R.; actual length, snout to vent, 125 mm.; total length, 282 mm.

prefrontals (much smaller in the type) their mutual suture about one third of their length, and touching three supraoculars laterally; parietals not separated by the interparietal, their posterior inner edges forming a suture; four pairs of much widened nuchal scales; a postnasal present behind the posterior nasal; two loreals the anterior higher and much widened at top, and generally slenderer than posterior; four supraoculars the second largest; three well-defined presuboculars, eight supraciliaries, three or four small preocular scales, one touching the loreal; four postsuboculars; primary temporal small, quadrangular; secondary temporals large, the upper elongate, the lower triangular; three tertiary temporals. Seven supralabials followed by two superimposed pairs of postlabials. About 27 irregular scales about ear-opening, three of the anterior scales form lobules; five supralabials precede the subocular supralabial; mental bordering mouth a somewhat longer distance than rostral, nearly twice as wide as deep; seven lower labials, a single postmental followed by three pairs of chinshields, only the first pair forming a median suture; scales on dorsum, from parietal to above vent, in 67 transverse rows, of which four are nuchals, followed by seven paired scales, and these in turn followed by 56 typical body scales; scales about anterior part of neck, 31; about narrow part of neck, 23; about middle of body, 17; about axillary region, 26; about base of tail, 13. A total of 83 subcaudals all about five times as wide as long except two pairs following the vent (the terminal portion of the tail is regenerated); a tiny patch of granular scales in axilla and a similar elongate patch behind leg insertion.

Third and fourth fingers equal in length, each with twelve scales on under surface; palm covered with equal scales and three light padlike scutes larger than others; fourth toe distinctly longer than third, with sixteen keeled scales below; three large padlike scales on heel.

Color in life: Above rather yellowish brown, the head somewhat lighter, rather more grayish brown on sides; a light lemon-yellow wash on venter; chin whitish; the dorsal scales each with one or two darker areas that form discontinuous darker lines, two median, and one each on other scalerows; chinshields and six ventral rows immaculate flesh with dark flecks appearing at base of tail and growing more numerous toward tip; each labial with a dark spot; each head scale with a darker mark, some with more than one.

Variation: Nos. 34186 and 34187 have the frontoparietals separated instead of forming a suture, while 34189 has them touching at a single point.

In the two young specimens the outer ventral scalerows may have some dark flecks. The general color above is wood-brown with the dark lineation strong and continuous. In the younger specimen the yellow of the venter is more pronounced. It is remarkable that these specimens were collected on an airfield as was the type, the only other specimen known besides a British Museum specimen.

All were found under the edges of small boulders and two were taken from a small pile of stones. Several others seen escaped into masses of growing cacti about rocks. This is the southernmost record of the genus *Eumeces* in the Western Hemisphere.

Measurements in mm. of Eumeces managuae Dunn

Number	34185	34186	34187	34188
Sex	♂	♂	yg	yg
Snout to vent	125	104.5	62	57
Tail	157	145.5	30 reg.	41 broken
Snout to eye	8	7.2	4.8	4.4
Snout to foreleg	36.5	32	20	20.2
Axilla to groin	74	60	36.5	33
Arm	22	22	13	12
Leg	30	27	16	15
Width of body	19	16.5	11	9
Width of head	16	14	9	8.5

Genus MABUYA * Fitzinger

Mabuya Rafinesque, Anal. Nat., 1815, p. 76 (*nomen nudum*).
Mabuya Fitzinger, Neue Classification der Reptilien, 1826, pp. 23, 52 (type of genus *Lacerta mabouya* Lacépède, by tautonomy).**

Description of genus: Lower eyelid with a transparent disc (Costa Rican specimens); eyelids movable; limbs strong, well developed, the digits 5-5; nostril in posterior part of a single nasal; a pair of supranasals in contact or separated; frontonasal, prefrontals, frontoparietals, parietals, and an interparietal present; auricular opening distinct; digits with compressed single lamellae below. Palatine bones touch or overlap mesially; palatal notch separates the pterygoid bones.

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* "Ce nom de Mabouya, tire de la langue des Sauvages de l'Amerique septentrionale, designe tout objet qui inspire du degout ou de l'horreur". Lacépède.

** See Malcolm Smith, Fauna of British India including Ceylon and Burma; Reptilia and Amphibia, vol. 2, Saurians, 1935, p. 257.

This cosmopolitan genus extends from Veracruz and Colima in Mexico to Southern Brazil in the Western Hemisphere.

Sixty-one representatives of the genus *Mabuya* obtained by me in Costa Rica (1947-1954) are from fourteen localities distributed in either the Caribbean or Pacific drainage areas. In vertical distribution they range from sea level to about 800 meters and it is probable that the genus is not represented much above an elevation of 1,000 meters in Costa Rica. Experience in collecting suggests that the density of population throughout the range is uneven. Despite very considerable collecting at Moravia de Chirripó and Suretka no specimens were captured or seen, while at Turrialba, where more collecting time has been spent than elsewhere, only three specimens were taken, and no others were seen. Usually in localities where it occurs the species is conspicuous but elusive and only a small percentage of specimens seen are captured.

The Costa Rican material resolves itself into three species two of which occur in the same locality in the Pacific drainage areas and presumably the same is true in eastern Costa Rica in the Caribbean drainage. The chief problem is the determination of the proper names to apply to the material, not in determining the groups worthy of specific designation. In dealing with scincid lizards one usually finds in a species considerable fixity of color pattern for any particular age or sex. However, the actual variation within the species in certain head and body scales may be a little confusing. Thus, if the prefrontals are a trifle larger than normal they may be in contact thus separating frontal from frontonasal; if the internasals are narrowed mesially it may permit contact of frontonasal and rostral.

In scale counts around the middle of the body the variation, let us say, between 28 and 30 scale rows (occurring about 70 percent of the time) may indeed be trivial. In most scincs the scales immediately behind the arm are smaller and a scale count on the body just back of the axilla may show, let us say, 36 rows. From here back to the middle one may find a point where there are 34, or farther back, 32 scalerows. Between this point and the actual middle, where the count is to be made, two rows will normally drop out on each side but if only one fails to do so, a count of 30 is obtained; although in one animal they may drop out one or two transverse rows before—in another the same distance behind this point where the count must be made.

The taxonomy of the genus *Mabuya* as it applies to species of the

Western Hemisphere is seemingly in a bit of confusion. As, for example, a recent reviewer discusses what he regards as a subspecies of this genus, that is said to extend from middle Mexico, south into South America and the West Indies. This varies in rather extraordinary fashion. For example transverse scalerows on the venter vary between 48 and 72. One suspects that more than a single species is involved.

KEY TO THE SPECIES OF MABUYA IN COSTA RICA

1. Adpressed legs separated; fifth labial (subocular) below eye; scales from parietals to above vent, 59-61; normally 30 scalerows (rarely 28 or 32); two pairs of chinshields touch labials; uniform brown or each scale brown with a darker center. Pacific (and possibly Caribbean) drainage area .... *brachypodus*

   Adpressed legs overlapping; sixth labial (subocular) below eye; scales, parietal to above vent, 53-55 (males), 56-58 (females) 2

2. Frontonasal touches rostral normally (or is minutely excluded from rostral); scale rows, 26-28 (rarely 27 or 29); normally two pairs of chinshields touch labials. A dorsal pattern of dark and lighter lines. Caribbean drainage area .... *alliacea*

   Frontonasal separated from rostral; normally one pair of chinshields touch labials; brown above with numerous dark flecks, lacking darker or lighter lines. Normally 30 scalerows, rarely (28-32). Pacific drainage area .... *unimarginata*

With the action of Smith and Taylor, restricting the type locality of *Lacertus mabouya* to St. Vincent Island, it must be regarded as doubtful whether the species *Mabuya mabouya* is represented on the mainland of Central America by subspecific forms. Only a review of the material by a competent observer can decide this point.

The number of transverse scalerows is usually two to five higher in females than in males. The range in both sexes is from 62 to 69, the average being near 66. Normally the first loreal (postnasal) is narrower than the second, higher and tending to curve forward slightly. The second loreal is wider at top than bottom. However they are variable, often one or the other being excluded from the supralabials. I have seen only one specimen with the prefrontals touching and a single specimen with the parietals separated.

Color variation is somewhat a matter of age. Adults are generally brown above with black and dull cream or tan markings. The chin is creamy white. The breast and abdomen are yellow; an area behind the vent may be salmon or yellowish. The under surface of the tail is gray. In the young the tail is bluish or bluish black, but this color is lost rather early in life. On the underside of the legs there is often a shade of pink.

Mabuya alliacea Cope

(Fig. 74)

Mabuia alliacea Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1876 (1875), p. 115, pl. 6, fig. 1 (type locality, "Costa Rica" "low country." "Large preanal scuta and long muzzle distinguish this species from the *M. cepedii*"); Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Oct. 1885, p. 33 (no specimens); Boulenger, Catalogue of the lizards in the British Museum, vol. 2 ,1887, p. 193 (no specimens); Ahl. Sitzb. Akad. Wiss. Wien, Math-naturv. Kl. Abt. 1, Bd. 143, Heft 1 and 2, 1934, pp. 30, 31.

Mabuya mabouya mabouya (*part.*) Dunn, Proc. Acad. Nat. Sci. Philadelphia, vol. 87, 1935, pp. 537-546; Smith and Taylor, U. S. Nat. Mus. Bull. 199, p. 156 (*part.*).

Diagnosis: Dorsal color pattern consisting of light gray or olive, and black longitudinal lines; a lateral line of white or cream from snout along lip, neck, and side of body, bordered above by a broad black stripe and below by indefinite dark olive, not flecked or spotted, merging into ventral coloration.

Legs overlapping when adpressed (100 percent)*; sixth labial (subocular) below eye (84 percent); one pair of nuchals (100 percent); frontonasal touches rostral (82 percent), or minutely excluded from it (18 percent); frontal touches frontonasal (94 percent); parietals in contact (100 percent); axillary pit reduced but evident. Scalerows 28, (59 percent); 26, (23 percent); 29, 11 percent; 27 (5 percent); normally two pairs of chinshields touch labials (70 percent).

Description of species (From KUMNH No. 48987, Inter-American Institute of Agriculture, Turrialba, Cartago Prov., Costa Rica): Rostral well visible above, bordered by nasals, internasals, first labials, and frontonasal; latter much wider than long, touching first loreal and supranasal laterally; prefrontals reaching laterally to touch two loreals, first supraciliary, first and second supraoculars; frontal one and two-thirds times as long as wide, its length greater than its distance from tip of snout, equal to its distance from the posterior edge of parietals, touching second labials laterally and the frontoparietals posteriorly; each of the latter scales touch three supraoculars, their greatest length equal to length of interparietal; parietals large, considerably wider than long (5.1 mm. x 3.5 mm.), enclosing the interparietal which is as wide as long.

Internasals narrow, of near equal width throughout, separated from each other; nasals with nostril pierced in posterior part, with a suture entering nostril from upper edge; a small postnasal very closely approximated to nostril; two loreals, the second largest; a

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* The percentages may depend on more specimens than are listed in the table given herewith.

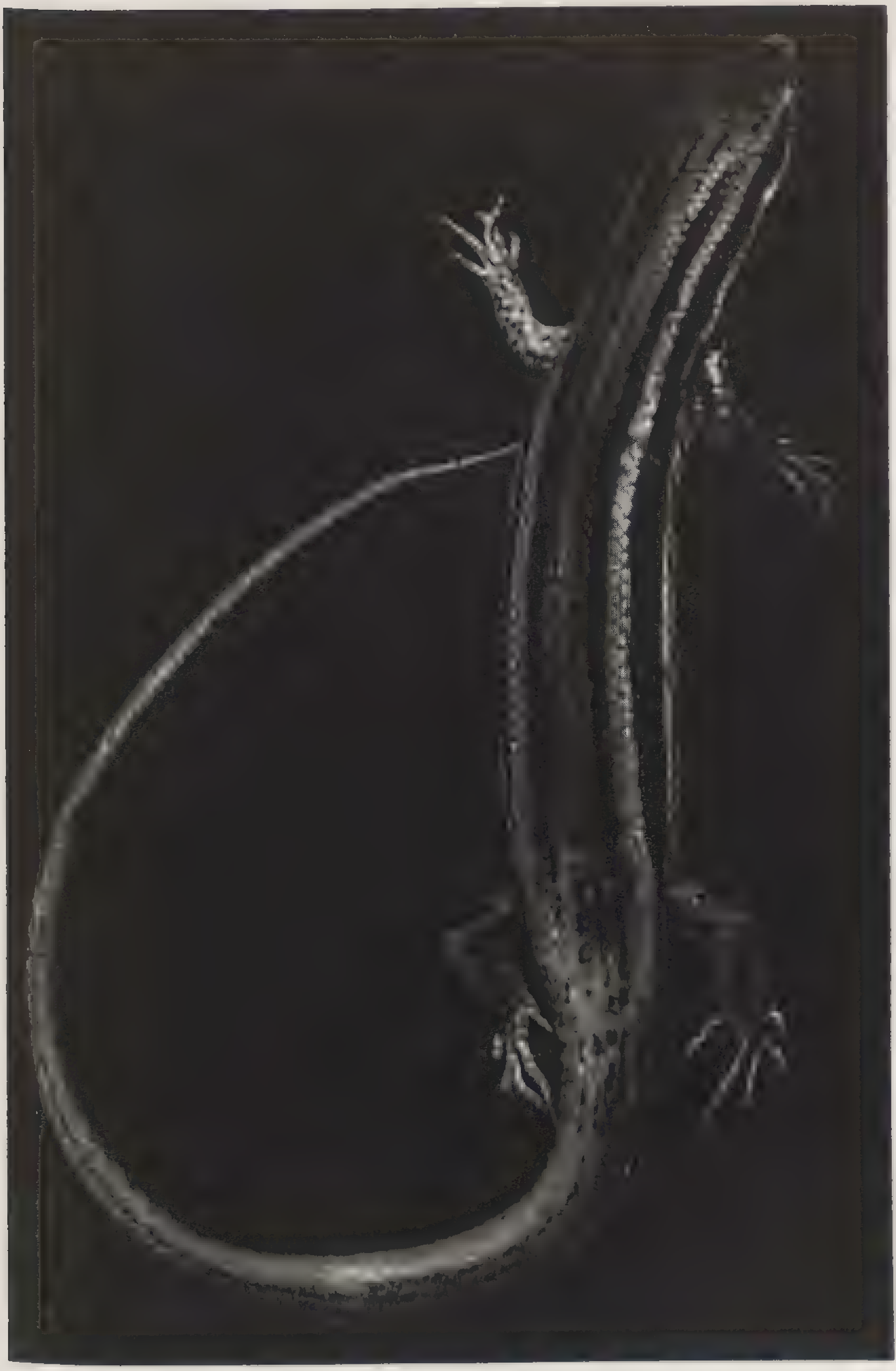

FIG. 74. *Mabuya alliacea* Cope. KUMNH No. 34326, Turrialba, Cartago Province, C. R.; actual length, snout to vent, 88 mm.; total length, 246 mm.

preocular, and following this two small scales; four supraoculars, first small excluded from frontal; four supraciliaries, second elongate; a series of scales border the supraciliaries and these with two or three rows of granules separate supraciliaries from the palpebrals; lower eyelid with a transparent disc, bordering the infrapalpebrals and separated from the subocular by about six rows of granular scales; five supralabials (four on left side) precede the elongate rectangular subocular, and three labials follow; eight or nine infralabials; mental border of the lip greater than that of rostral; an azygos postmental touching two labials; first and second pairs of chinshields border labials, the first pair in contact mesially, the second separated by a scale; the scale following widened (third chinshield), separated by an elongate scale from labials and from its mate by a single scale. A series of five postoculars, the upper scale as large as a temporal; this series preceded by another small row, the upper likewise largest; temporals 2 + 2 + 3 + 4, the uppermost scales largest; a pair of nuchals; about fourteen scales surround ear, one or two projecting over the anterior edge. Scales around neck, 28; about middle of body, 28; scales smooth with a faint suggestion of a pair of striae, so dim as to be seen only in certain lights; lamellae under two longest fingers, 14; under longest toe, 15; palm and sole covered with pavementlike granules, the two on back of palm and two on heel largest. From mental to vent, 60 ventral scales; subcaudal scales (tail complete), 111; four median preanal scales enlarged, with two smaller ones on each side also bordering vent; a small axillary indentation or pit, the bottom covered with small, erect granular scales.

Color in life: Above, on head and front of body, bronze to olive bronze becoming more olive on back of body and tail; a dorsolateral line beginning at eye, bronzy green to olive, the outer edge being dull bluish-white on a portion of each scale, and forming a distinguishable line of nearly triangular dots; a dorsal black stripe covering part of two scalerows follows along the dorsolateral stripe on its inner border to tail; two median scalerows with very narrow, often discontinuous black lines; a broad black or brownish-black stripe from nostril through eye to tail, many of whose scales show very indefinite flecks of olive or metallic olive; below this, beginning on the tip of snout, a cream-white or ivory line anteriorly, becoming greenish white posteriorly, as wide as half a scale, but usually covering edges of two adjoining rows; only lower part of auricular opening included in the line; below, this line bordered by a narrow black line as wide as the white line; color below this on neck and

Measurements in mm. and scale data on Mabuya alliacea Cope

Number	Sex	Snout to vent	Tail	Head width	Head length	Snout to ear	Snout to arm	Axilla to groin	Arm	Leg	Scale rows at middle	Labial below eye	Rostral touches fronto-nasal	Scales parietal to above vent	Chin-shields touch labials
34326	♀	88	158	12.8	17	15.2	30	49	23	28	28	6–5	yes	57	2–2
34327	♂	72	....	11	16.2	13.5	25	38	21.5	26.5	26	6–6	yes	53	2–2
34335	♂	70.5	....	11.4	16	14.2	25	35	21	25	28	6–6	yes	54	2–2
34342	♂	70	125	12	16	13.2	24	39	21	28	26	6–6	yes	54	2–1
34347	♀	44	....	7.5	10.5	9	17.6	23	13	16.6	29	6–6	yes	58	2–1
34328	♂	71	....	11	16.2	12.5	26	39	21	26	29	6–6	yes	55	1–1
34329	♂	66	....	11.5	14.5	13	26	35	20	26	28	5–5	yes	54	2–2
34330	♂	76	156	11.8	16	13	27	37	22	28	28	6–6	yes	55	2–2
34331	♀	49	91	8.5	12	10	17.6	24	13	18	26	6–?	no*	58	1–1
34332	♀	84	....	12	17	15.4	29	44	23	30	28	6–6	yes	58	2–2
34333	♀	71	135	11	16	13	24	36	22	26	28	6–6	yes	58	2–2
34334	♂	72	....	11	16.8	14	23	38	20.5	27	26	6–6	yes	54	1–1
34336	♂	72	....	10.8	16	12.7	23	35	21	24	27	6–6	yes	55	2–2
34337	♀	77	....	12	15	13	25	42	20.5	27	28.5	6–6	yes	57	2–2
34338	♂	68	....	11	15	13	23.4	33.5	20	26	28	5–5	no*	55	1–1
34339	♀	74	....	11.6	16	13.3	24.6	38	20	25	28	6–6	no*	58	2–2
34340	♂	71	....	10.2	15	13	26	35	22	25	28	6–6	yes	55	2–2

side bronzy olive; chin ivory, belly greenish white with metallic reflections; tail generally olive with darker flecks on its dorsal surface; a few black flecks on occiput; preanal scales dirty white; arms and legs olive-brown, speckled with black; under part of hands and feet, black, speckled olive above.

The ventral color of this specimen changed in preservation; pigment has moved to edges of scales, thus leaving a series of distinguishable longitudinal lines of ultramarine separated by lines of gray or bluish white, the edges of these lines indefinite.

Measurements in mm.: Snout to vent, 88; tail, 158; head width, 12.8; head length, 17; snout to ear 15.2; snout to arm insertion, 30; axilla to groin, 49; arm, 23; leg, 28.

Variation: A table of measurements and scale data here presented gives the chief variation that occurs in the specimens. The following KUMNH specimens are at hand: Cartago Province: Nos. 34326-27, 34335, Turrialba; 34342, 34347, Lake Bonilla, near Tunnel Camp. Limón Province: No. 34328, Los Diamantes, Guápiles; 34328-34334, Bataan; 34336-34338, Limón; 34339-34340, La Lola.

The general color pattern is maintained in all of the specimens. Sometimes the outer dorsal black stripe is not solid and the black color covers only the outer part of the scalerows leaving a lighter streak down through the middle, thus one may count six dark dorsal lines.

Remarks: The species is ovoviviparous. A specimen, (No. 34339) contains several nearly full-time embryos, each showing the typical color pattern. Ahl (*loc. cit.*), describes a specimen from Finca Hamburg on the lower Río Reventazon, near Siquirres, Limón Province. Dunn (*loc. cit.*), had specimens from several localities in Costa Rica but possibly he has confused more than one species under a single name.

Mabuya unimarginata Cope

(Fig. 75)

Mabuya unimarginata Cope, Proc. Acad. Nat. Sci. Philadelphia, 1862, pp. 186-187 (type locality, "Panama").

Mabuya aurata Boulenger, Catalogue of the lizards in the British Museum (Natural History), 2nd Ed., vol. III, 1887, pp. 189-190 (*part.*) .

Mabuia agilis Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Oct. 1885, p. 33 (*part.*).

Mabuya mabouya mabouya Dunn, Proc. Acad. Nat. Sci. Philadelphia, vol. 87, 1935 (Feb. 11, 1936), pp. 537-546 (*part.*); Ahl, Sitzungsb. Ges. naturf. Freunde Berlin, 1940, p. 247; Mertens, Abh. senckenb. naturf. Ges Frankfort a. Main, No. 487, 1952, p. 58.

Mabuya mabuya mabuya Slevin, Proc. California Acad. Sci., vol. 23, no. 32, June 25, 1942, p. 467 (Boquete, Panamá).

Cope's original description of this species (*loc. cit.*) is as follows: "Form slender, head as wide as the neck to the orbits, the muzzle not elongate; scales (in the specimen described) in thirty-two rows. Supranasals in contact; frontal elongate, not truncate anteriorly; a postnasal. Supraoculars four; superior labials eight, eye over sixth. Adpressed limbs overlapping. Seven marginal anal plates. From muzzle to tympanum 6 lines; from muzzle to vent 2 in. 7 lin.; from vent to end of tail 3 in. 10 lin.; anterior extremities 9 lin.

"Above rather dark brown; a narrow black band extends from the end of the muzzle to the groin, which has a bright yellow inferior border. Beneath this the sides are brown. Abdomen yellowish.

"*Habitat:* Panama.

"This species resembles the *cepedii* and *aenea*."

I am not wholly convinced that this name is definitely applicable to the population dealt with here. The type is presumably lost. Moreover I have no information as to the probable exact type locality unless the habitat "Panama" refers to the city. I am, however, using this name, well aware that future Panamanian collections may demand that another name be used for the population here considered. The character, and an important one, in which the type description differs, is in color pattern, no mention being made of the black flecking that occurs on the dorsal scales of all specimens examined.

Diagnosis: Above, the color on head and body brown with very numerous black flecks scattered or tending towards forming a reticulation; a dim dorsolateral light line sometimes evident; a lateral stripe beginning at eye nearly solid black to groin, bordered below by a bluish-white line beginning on tip of snout; below this a dark stripe on neck and sides of body that has very numerous tiny lighter flecks; greenish white below. A large species, 88 mm. snout to vent; scalerows usually 30 (rarely 28 or 32); frontonasal separated from rostral (100 percent); eye above sixth labial, (82 percent) above fifth labial (18 percent) (only four out of 31 with five on both sides). Scales, parietals to above vent ♂ 54-56, ♀ 56-58; frontonasal does not touch rostral (100 percent); frontonasal touches frontal (96 percent) one or two pairs of chinshields touch labials (71 percent, 29 percent) (only three out of 31 having two on both sides); one pair of nuchals (71 percent) 2 pairs (29 percent).

Description of species (From KUMNH No. 36306. Agua Buena, Puntarenas Province, Costa Rica): Rostral well visible above, its height (1.6 mm.), one half its width (3.22 mm.); supranasals

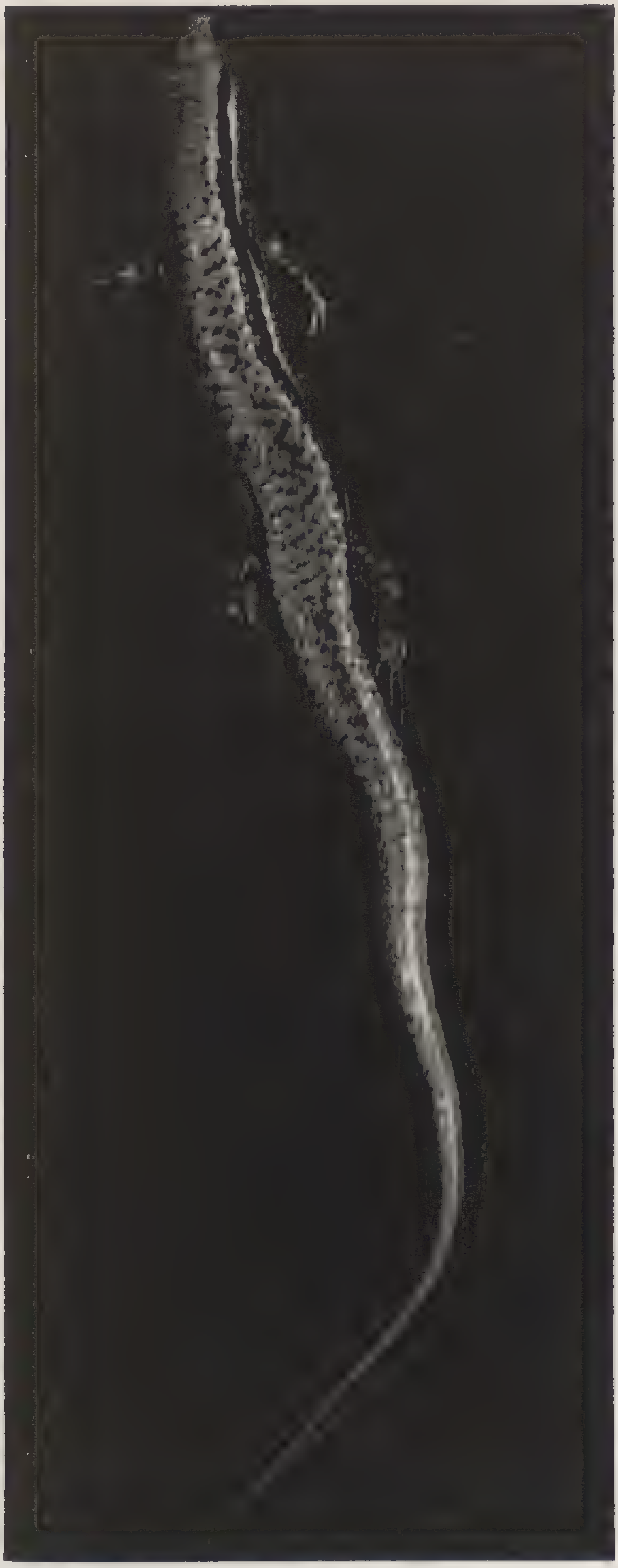

Fig. 75. *Mabuya unimarginata* Cope. KUMNH No. 36306, Agua Buena, Cañas Gordas, Puntarenas Province; actual length, snout to vent, 81 mm., total length, 214 mm.

broader anteriorly than posteriorly, forming a strong median suture; frontonasal broader than long (3.7 mm. x 2.7 mm.) separated from the rostral but very narrowly in contact with the frontal, touching anterior frenal; prefrontals large, bordering both loreals equally, touching first supraciliary and first and second supraoculars; frontal longer than wide (4.2 mm. x 2.8 mm.) somewhat diamond-shaped, the posterior point slightly rounded, touching a single supraocular and both interparietals; latter scales touch two posterior supraoculars; four supraciliaries; interparietal slightly longer than wide, enclosed by the parietals; latter scales much wider than long, touching two postoculars, two temporals, and nuchal; nostril pierced in posterior part of a single nasal, with an entrant suture from upper rim of nasal; postnasal present; two loreals, the upper fused to a small upper preocular (abnormal?); lower preocular followed by a single presubocular; supraciliaries separated from palpebrals by about three rows of granules; lower eyelid with a transparent disc, bordered above by infrapalpebrals, and from subocular by seven rows of small granules; eight supralabials, fifth below eye, sixth with a scale segmented from its upper part, seemingly making three instead of two anterior temporals. Three rows of small postocular scales, the upper of each series largest; temporals 3 + 3 + 4; about eleven scales surround ear-opening, at least two overlap the front edge of the opening; seven infralabials; mental more than twice as wide as long, with a labial border greater than that of rostral; azygos postmental touching two labials; a single pair of chinshields touching labials, in contact mesially; second pair separated from labials by one scale, the third pair by two scales, the second and third pairs scarcely differentiated; arm and leg overlapping when adpressed; two middle fingers with 14 lamellae, the longest toe with 18; sole and palm covered with juxtaposed granules, that at heel enlarged; eight preanal scales, four median the larger; body scales smooth with a faint trace of two striae; 29 scales around neck; 30 around middle of body; 108 subcaudals; 57 from parietals to above vent; the axillary pit barely evident, much reduced in size and depth.

Color in life: Above, brown on head and body, the head unspotted, the dorsum heavily spotted or flecked with black; a broad black lateral stripe beginning at nostril and extending to groin, the upper edge of which has a series of small light-olive dashes forming an indefinite discontinuous row; a line beginning on tip of snout is cream on labials becoming bluish white in front of ear and continuing to groin, the edges irregular; below this on chin and sides of body a brownish black line covering about three scale rows with small dashlike marks of brownish cream or olive-green; these are continued along tail to tip; below light bluish- to greenish-white, with metallic reflections; (in preservation, the color below is light ultramarine, each scale with a somewhat lighter center); the upper part of supralabials dark brown; a series of darker marks on the sutures of the infralabials; under-side of sole, palm, and digits black; subcaudal areas colored like venter; arms and legs brownish black, with dashlike lighter marks.

Measurements in mm.: Snout to vent, 79; tail, 137; head width, 11.8; head length, 17.5; snout to ear, 14; snout to arm, 26; axilla to groin, 43; arm, 21; leg, 27.

Variation: The table of measurements and scale data accompanying this description details much of the variation. The degree of overlap in the adpressed limbs may be ascertained by comparison of the combined length of the limbs with the axilla to groin measurement. The variation is due in part to sex, the adult females usually having a slightly longer axilla-to-groin measurement than males; moreover the limbs tend to grow but little in old age and younger specimens have longer legs proportionally. I suspect that on the whole females reach a larger size than males. There is no reduction in the number of the supraoculars. In the supraciliaries the last may be divided so that a count of five results occasionally. A fusion of the first two in two cases give a count of three (on one side only). In a few cases there are three temporals in the first row instead of the expected two.

Remarks: The specimens of this species at hand are as follows: San José Province: Nos. 25608-25618, 34318-34325, environs of San Isidro del General. Puntarenas Province: Nos. 36310-36311, 15-18 km. WSW San Isidro del General; 36300-36309, Agua Buena, Cañas Gordas. Guanacaste Province: No. 36314, 4 km. ENE Tilarán.

The finding of the two species of *Mabuya* in the same region (about 7 miles apart and at about the same elevation) speaks strongly that two species (not subspecies or lesser categories) are involved.* While this species is to be expected on the Caribbean Coast I have obtained no specimens there. Cope believed he had two species from southeastern Costa Rica collected by William Gabb.

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* This other species is *Mabuya brachypodus*. See following description.

Measurements and scale data on Mabuya unimarginata Cope

Number	Sex	Snout to vent	Tail	Head width	Head length	Snout to ear	Snout to arm	Axilla to groin	Arm	Leg	Labial below eye	Sub-caudal scales	Scales parietal to above vent	Scale rows	Fronto-nasal touch rostral	Fronto-nasal touch frontal	Chin-shield touch labials	Nuchals
25608...	♀	81	......	11.2	16	14	27	42	21	29	6–6	......	58	30	no	yes	1–1	1–1
25609...	♀	63	......	10	14	12	30	35	16	21.2	6–6	......	57	30	no	yes	1–1	2–1
25610...	♀	68	......	10.3	15	13	24.5	35	20	27	6–6	......	57	30	no	yes	1–1	1–2
25611...	♂	52	......	8.3	11.5	10.6	19.5	28	14.2	20	6–6	......	54	30	no	yes	1–1	1–1
25612...	♀	88	......	12	18	14.2	28.5	49	22.5	28	5–6	......	58	30	no	yes	1–1	1–2
25613...	♂	77	......	13	17	15	28	40	21	28	5–6	......	54	28	no	yes	1–1	2–1
25614...	♀	85	......	11.8	16.2	14	27	44	20.5	27	5–6	......	58	30	no	yes	1–1	1–1
25615..	♂	65	......	10	14	12	20	35	18	21.5	6–6	......	55	30	no	yes	1–1	1–1
25616...	♂	56	......	8.9	14	11.8	20.2	28	15.2	21	6–6	......	54	30	no	yes	1–1	1–1
25617...	♂	62	111	10	14.6	12	22	35.5	16	23	6–6	112	54	30	no	yes	1–1	1–2
25618...	♀	64	......	10	14	12	20.5	37	18	22	6–6	......	57	32	no	yes	1–1	2–1
34318...	♂	57	95	9	13	10.8	20	28.8	16	19	6–6	111	56	30	no	yes	1–1	1–1
34319...	♂	84	......	12	18.2	13.5	29	45	21.3	29	6–6	......	56	30	no	yes	2–2	2–2
34320...	♀	......	......	12	18	16	......	......	20	28	6–6	......	......	......	no	yes	1–1	2–1
34321...	♂	72	......	11.5	16	14	28	39	18	23	6–6	......	56	30	no	yes	1–1	1–2
34322...	♂	73	......	10.8	16	14	22.6	37	19	26	6–6	......	56	30	no	yes	1–1	2–2
34323...	♀	56	85 +	8.5	13.2	11	19	30	14	19.5	5–5	102 +	56	30	no	yes	1–1	1–1
34324..	♀	77	......	10.8	16.2	14	25	39.2	21	27.4	6–6	......	57	30	no	yes	1–0	2–1
34325...	♀	61	105	9.6	13.5	11	19	32	16	22	6–6	113	57	29	no	yes	1–1	1–1
36310...	♂	73	122	11	15	13	24	41	19	26	6–6	108	55	32	no	yes	1–1	1–1
36311...	♀	57	93	9	13	11.8	20	30	16	21	6–6	107	60	32	no	yes	1–1	1–1
36300...	♂	57	......	9	12.2	11.2	20.6	30	15.6	20	6–6	......	54	30	no	yes	1–1	1–1
36301..	♂	59	......	8.8	13	11.3	21	30.5	16	20	5–5	......	55	30	no	yes	1–1	1–1
36302...	♀	55	......	8.2	13	11	19	28	16	19	6–6	......	58	32	no	yes	1–1	1–1
36303...	♀	61	103	9	13.2	12	21.2	33	17	22.2	6–6	108	57	30	no	yes	1–1	1–1
36304...	♂	64	113	9.8	14.2	12	23	33	18.2	24	6–6	105	56	31	no	yes	1–1	1–1
36305..	♀	54	......	8.1	12.5	11	20	27	15	19	6–6	......	56	30	no	yes	2–1	1–1
36306...	♀	79	137	11.8	17.5	14	26	43	21	27	5–5	108	57	30	no	yes	1–1	1–1
36307...	♂	60	......	9	13.6	11.8	21	31	17	22	6–6	......	55	30	no	yes	1–1	2–1
36308..	♂	63	......	9.8	14.4	12	22	34	17.6	23.6	6–6	......	55	29	no	yes	2–2	2–2
36309...	♂	72	......	10.4	16	14.2	24.4	35.3	21	27.2	6–6	......	55	30	no	yes	1–1	1–0
36314...	♂	58	......	9	12.3	11.2	21	29	15.3	20	5–5	......	54	30	no	yes	2–2	1–1

Mabuya brachypodus sp. nov.

(Fig. 76)

Type: KUMNH No. 36258; collected 4 km. ESE of Los Angeles de Tilarán, Guanacaste, Aug. 15, 1954 by Edward H. Taylor.

Paratypes: No. 34326, Palmar; Nos. 36312-36313, Barranca; Nos. 34310-34313, Maribella Hotel, at mouth of the Río Barranca at sea level,—all from Puntarenas Province. Nos. 34314-34317, Tenorio, Las Cañas, Guanacaste Province.

Diagnosis: Head and dorsum brownish, with none or only a dim dorsolateral light line; a black stripe from eye along side to groin, bordered below by a bluish or greenish white line beginning on tip of snout; the light line bordered by a dotted black line below. When limbs are adpressed, they fail to meet by a distance equal or greater than length of hand; fifth (subocular) labial below eye; one pair of nuchals; parietals normally in contact; usually two pairs of chinshields touch labials; scales from parietals to above vent, 59 to 61; scale rows usually 30 (sometimes 28 or 32).

Description of the type: Rostral rather narrowly visible above, more than twice as wide as high; a pair of supranasals, wider anteriorly than posteriorly, in contact on median line; frontonasal much wider than long (2.3 mm. x 3.5 mm.), touching first loreal laterally, but excluded from contact with rostral and frontal; prefrontals large, in contact on median line, touching two loreals laterally, and (normally) first supraciliary, first supraocular, and frontal (on right side the first and second supraoculars are abnormally fused and the right prefrontal is likewise fused along a part of its suture with the frontal); frontal minutely less than twice as long as wide; frontoparietals larger than interparietal; latter with a strongly convex suture with the frontoparietals; parietals touching two postoculars and two temporals laterally, much wider than long (5.2 mm. x 2.8 mm.), in contact behind interparietal; one pair of nuchals; scales following nuchals enlarged (fusion of two body scales?); nostril a diagonal oval, pierced in posterior part of nasal, without an entrant suture from upper rim; a small postnasal; first and second loreals subequal; one (or two) preoculars and a presubocular below it; two rows of postoculars, the upper of each series largest; temporals 2 + 2 + 3, 2 + 3 + 3; eight supralabials, the fifth under eye; eight infralabials; mental with a larger labial border than rostral; a large postmental bordered laterally by two infralabials; two pairs of chinshields in contact with labials, the first pair touching each other mesially, the second pair separated by a single scale; third

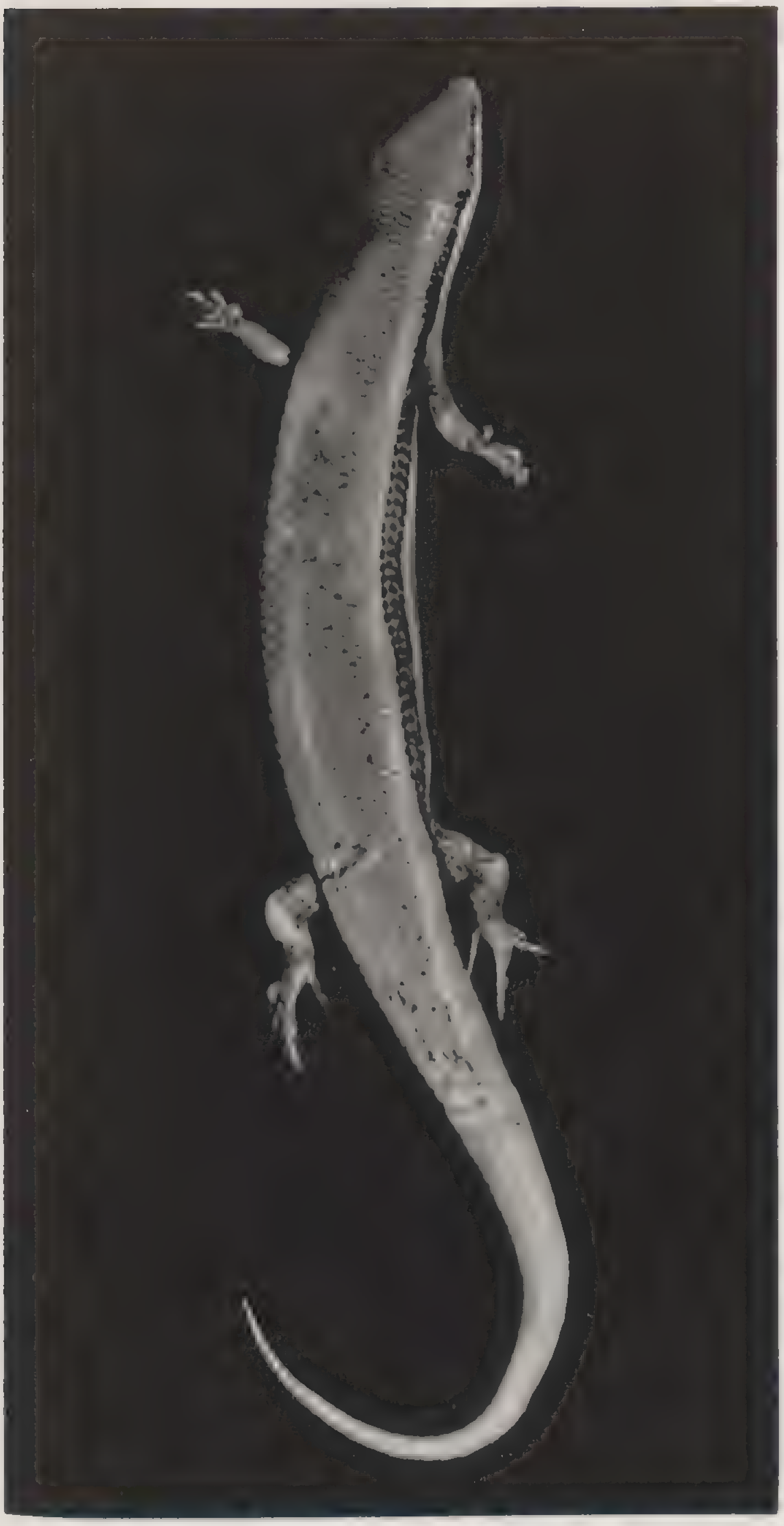

FIG. 76. *Mabuya brachypodus* sp. nov. KUMNH No. 36258, 4 km. ENE Tilarán, Guanacaste, C. R.; actual length, snout to vent, 82 mm.

chinshields enlarged, separated from labials by a single scale; ear surrounded by about 14 scales; lower eyelid with a transparent disc, bordered above by a row of palpebrals, separated from subocular labial by about five rows of granular scales; four supraciliaries, second elongate, separated from the palpebrals by two rows of granular scales.

Arms short, with a well-defined axillary pit, the surface of which is covered with small erect scales; two middle fingers each with twelve lamellae; longest toes with 16 lamellae; vent bordered by eight scales, the four mesial scales somewhat enlarged; scales around neck, 28; around middle of body, 30; sole and palm covered with small juxtaposed granular scales, those at wrist and heel but little larger than adjoining granules; scales from parietal to above vent, 59.

Color in life: Above olive brown to brown, the head and body immaculate save for a very few flecks on the rump and tail base; a very indefinite olive-brown line borders the edge of the dorsal coloration tending to be less conspicuous after preservation; the black stripe from eye along side of neck and body is not of solid color, but the black covers only part of each scale; below this a bluish-white line from snout-tip to groin covering supralabials and surrounding ear-opening; below this light line an olive band, the upper edge of which has a row of small triangular black flecks. Chin and venter nearly white, remaining so in preservation; under side of hand and foot dirty white; some brown flecks on infralabials below eye.

Measurements in mm.: Snout to vent, 82; tail (regenerated); width of head, 12; length of head, 16; snout to ear, 13; snout to arm insertion, 25.4; axilla to groin, 41; arm, 16; leg, 23.5.

Variation: Two problematical specimens captured at Barranca show a dark lineation through each scalerow. The larger of the two is a female with uterine young. Except for this color pattern difference they agree with the remainder of the specimens of this species. It is, of course, possible that these represent a form worthy of taxonomic recognition occurring on the Peninsula of Nicoya an area that in the past may have been isolated by water from the mainland. For the present I am associating these specimens with the form here discussed.

This species seemingly follows up the Pacific coast at least as far as San Salvador. Mertens (1952)* reports on El Salvador speci-

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* Mertens, Abh. Senckenb. naturf., Ges., No. 487, 1952, p. 58, pl. 11, fig. 59.

Measurements and scale data on Mabuya brachypadus sp. nov.

Number	Sex	Snout to vent	Tail	Head width	Head length	Snout to ear	Snout to arm	Axilla to groin	Arm	Leg	Parietal separate	Labial below eye	Scales parietal to vent	Fronto-nasal touch rostral	Fronto-nasal touch frontal	Chin-shields touch labials	Scale rows
36312...	♀	71	......	9	13	11.8	21.7	41	16	23	no	5	61	yes	yes	2–2	30
36313...	♂	56	90+	8.8	13	10	20	29	14	20.5	no	5	60	no	yes	1–1	30
34326...	♂	64	......	9	13.2	12	23	36	18	19.2	yes	6	59	no	yes	2–1	30
34310...	♂	82	......	12.2	17	12.8	26	46	19	24.5	no	5	61	yes	yes	2–2	30
34311...	♂	68	......	10	15	12	24	38.5	16	20.3	no	5	60	yes	yes	2–1	32
34313...	♀	67	......	9	13	11.2	22	37.5	15.8	20	no	5	61	no	no	2–2	32
34312...	♂	66	......	10	14	11.8	23	35	17	21	no	5	60	no	no	2–2	30
36258...	♀	82	......	12	16	13	25.4	41	16	23.5	no	5	59	no	no	2–2	30
34316...	♀	75	......	10.2	14.8	11	12.5	41	16	21	no	5	59	no	no	2–2	30
34315...	♀	74	......	9.2	14	12	13	40	16.5	20.2	no	5	61	yes	no	2–1	30
34314...	♂	71.5	......	?	?	?	?	42	16	22	....	5	60	yes	no	2–2	28
34317...	♂	50	71	7.9	12.2	10.2	18.6	25	12	16	no	5	59	yes	yes	2–2	28

mens under the name *Mabuya mabouya mabouya* and gives an excellent figure. Differences between his specimens and those here reported are small, the dorsolateral line being a little more strongly evident and the flecking on the limbs a little more pronounced. The limbs when adpressed to the body fail to meet.

Remarks: It is probable that reports on specimens of this species have appeared in the literature under other names, the one just mentioned (*supra*) being such a case. My chief reasons for believing Cope's *unimarginata* is inapplicable to this form is that that species has overlapping limbs and the sixth labial is below the eye. In this species these facts are not true.

This form resembles more the northern mabuyas in Mexico. It may be that the Mexican form, now regarded as *alliacea* will prove to be a smaller subspecies of this form.

Four subcaudal counts are available, 111, 111, 110, 109: The nuchals are invariably 1-1; the parietals are invariably in contact and the frontal touches the frontonasal in all except a single instance.

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* See Stejneger (1936 footnote). Suggests that this work was actually written by Winterl.

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Selective Sensitivity of the Formed Elements of the Blood of the White Rat as Affected by Radium Chloride Injected Intraperitoneally*

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Abstract: The total white-cell count is lowered appreciably by giving radium chloride (in varying dosages over a short period of time) intraperitoneally to young male albino rats. The polymorphs are slightly more sensitive than lymphocytes. Blood platelets are also sensitive, reacting a little more slowly, but when they do they show a pronounced drop.

Until more accurate data are available concerning the rate of phagocytosis by liver, spleen, and bone marrow, as well as irradiation effect upon phagocytes, specific information concerning irradiation effects upon the formed elements of the blood must wait. Also, uniform sampling must be used for differences exist between various neural regions. For example, the white-cell count of blood from the heart may well be different from that of the periphery.

INTRODUCTION

This paper is concerned primarily with the sensitivity of the formed elements of the blood to radiations (chiefly alpha-particles) emitted by radium and its disintegration products. Ninety-six percent of total energy emitted by radium in total disintegration is associated with the alpha-particle emission. Of the remaining, 4 percent, only a fraction is absorbed in the body. Hence, the effects of the other radiations will be negligible (Hoecker & Roofe '49, '49a).

There are numerous papers in the literature dealing with the effects of radiation upon the peripheral blood. It is not the aim of this paper to present a review of this field. Jacobson & Marks ('47) emphasize the need for more quantitative work "to determine and evaluate incipient damage to personnel from radiation exposure in the 'tolerance range'." Their paper carries an excellent bibliography.

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Bloom's "Histopathology of Irradiation" ('48) does not deal with the peripheral blood directly but extensively discusses and surveys the work relating to the irradiation of the hemopoietic organs, which is most essential for the understanding of the peripheral picture. Suter ('48) has shown that the lymphocyte is more sensitive to massive doses of radiation than the neutrophil. This is contrary to what we have found for internal radiation from radium.

MATERIALS AND METHODS

Twenty-five young-adult white (Sprague-Dawley) rats were injected intraperitoneally with radium chloride in groups of five, the groups receiving the following dosages: 10, 20, 30, 40, 50 µg respectively. Ten animals served as controls. All were placed on a well-balanced diet and were kept in an air-conditioned room at 72-75°F. Extensive blood-cell counts were made prior to radium chloride treatment to determine the average counts. One animal from each group was sacrificed at three-day intervals up to and including the fourteenth day. This latter period was short one day. Two controls also were sacrificed on those days. All counts were done on the day of sacrifice. Samples of blood for all counts were obtained from the tails of the rats which had been cut just previous to the sampling. Several drops of blood were allowed to escape before the blood was drawn into the pipette or a drop used for a smear. Counts of both red and white blood cells were made by standard techniques using hemacytometer diluting Thoma pipettes and Spencer's bright-line Neubauer counting chambers. All counts were made in duplicate. Differential white-blood-cell counts were made using Wright's stain. For the platelet counts, the blood was diluted in red-blood-cell pipettes; the platelet solution containing brilliant cresyl-blue, sodium citrate, and formalin. The normal count and the experimental-group count (before treatment) had an average of 20,255 white cells per cubic millimeter. This was used as a base line. Each point represents the count on a single animal.

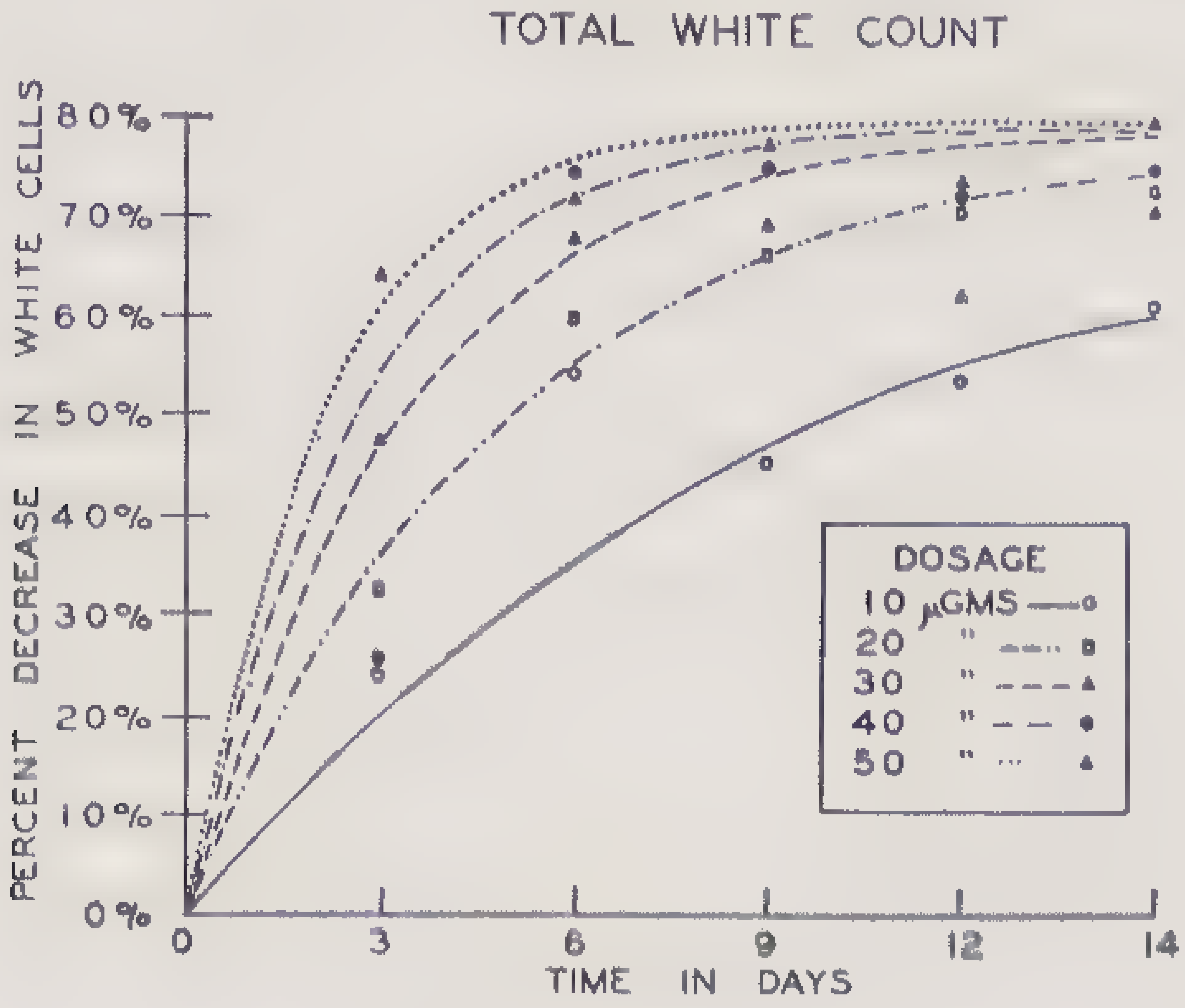
OBSERVATIONS

Red Blood Cells

During the period of this experiment there was no significant change in the red-cell count. On 164 counts of normal animals, the average red-cell count was 7,920,000 and the experimental did not deviate enough from this average (significantly) to be held statistically valid.

Total White Cells

Observable effects produced by the radiations (chiefly alpha-particles) from radium and its disintegration products present in the blood or in the hemopoietic tissues, appear to depend upon the amount of radium injected and the time elapsed after injection. The extent of this dependence is indicated in Figures 1 and 2. Although the same dates have been plotted in both figures, two sets of curves have been used in order to show more clearly the manner in which the percentage decrease in total white cells depends upon the two controlled variables, time and radium dosage.



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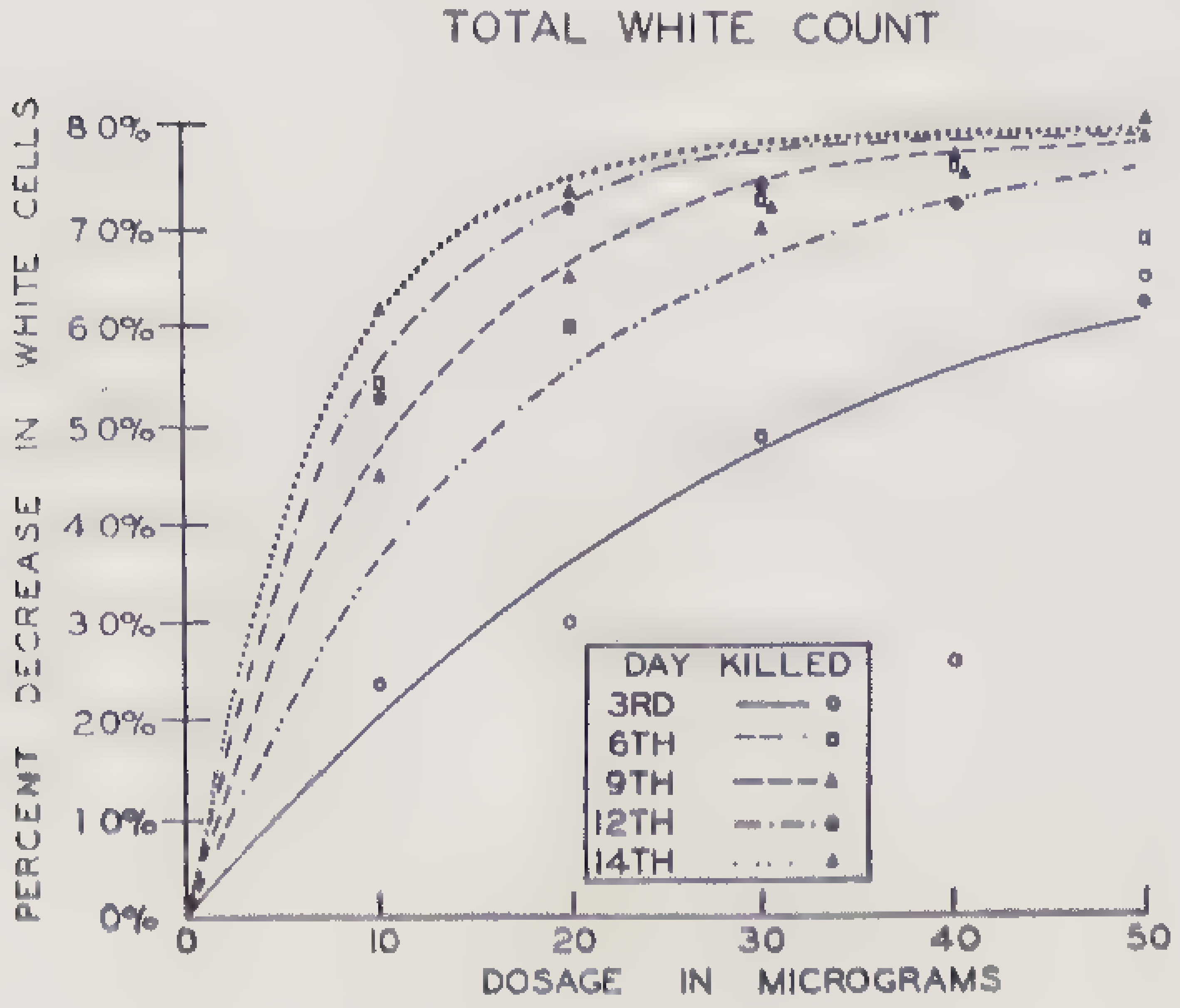

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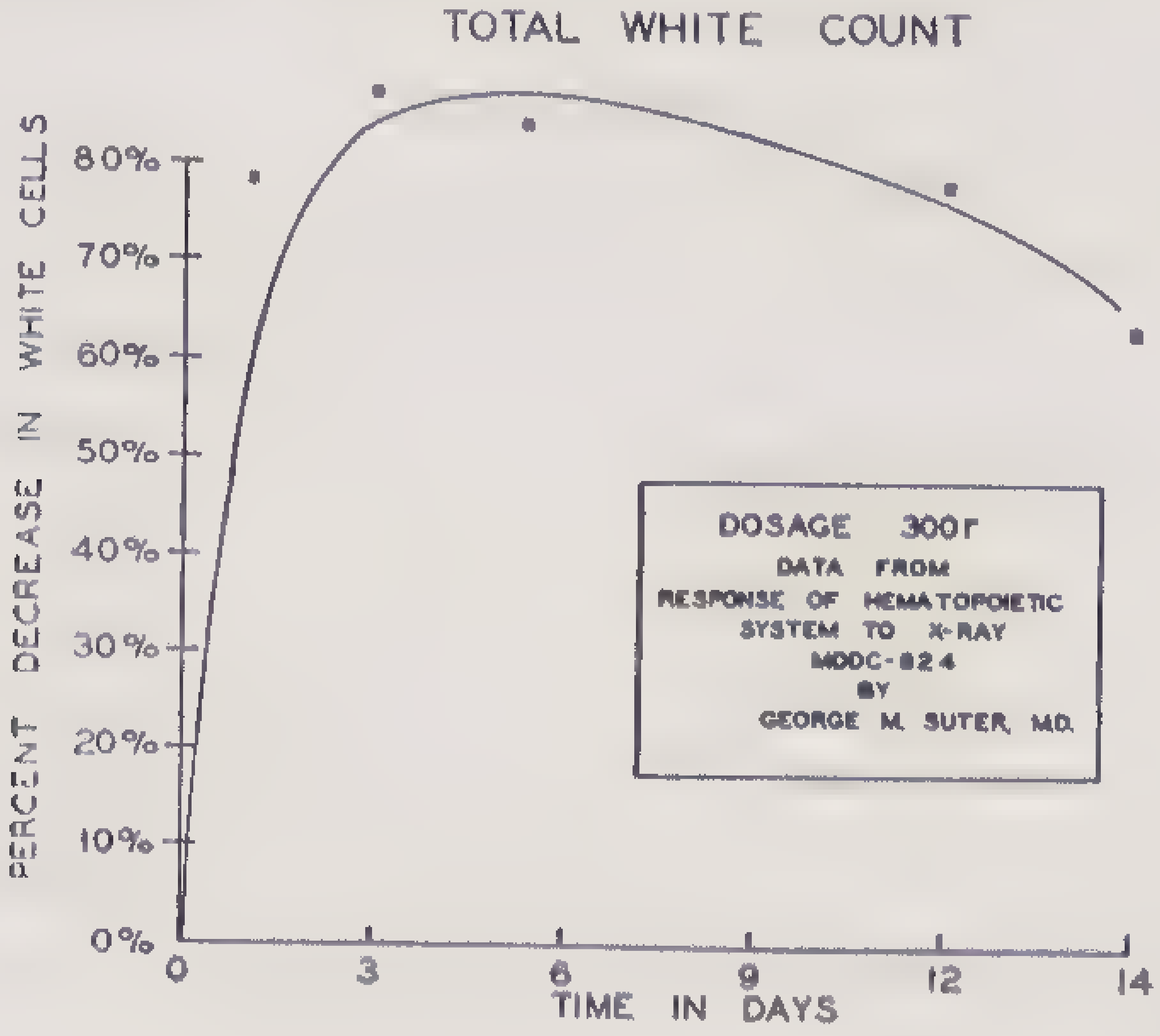
In Figure 1, five sets of data each representing a different radium dosage, have been plotted to show the effect of time on the percentage decrease in total white count for each given dosage. A saturation effect is evident after the fifth day following injection of radium. The effect of the radiation increases rapidly during the first five days but reaches its maximum and no further increase is observed after the sixth day for the four higher doses, 20, 30, 40, and 50 μg. The 10 μg curve is somewhat erratic, but rises more slowly and does not appear to reach saturation until near the end of the 14-day period.

This saturation effect is difficult to explain but certainly must be the result of several biological and physical factors. The purely biological factors are probably complex. Some of the factors, which must be in part responsible, are the rapid elimination of the radium from the blood stream and the soft tissues, including the bone marrow, through actual elimination from the body through deposition in the bone tissue where the hemopoietic tissues are no longer accessible to the alpha-particles. Another factor that has not been dealt with quantitatively is the rate of phagocytosis by the liver, spleen, lymph nodes, and bone marrow.

The same data are plotted in Figure 2, with percentage decrease in total white cells as ordinate but with dosage in micrograms as abscissa; the different sets of data now represent different times of sacrifice. The configuration of these curves is very similar to that of the curves discussed above, and indicates a dosage saturation effect. The rats killed on the third day after injection show a very marked dependence of white cell decrease on dosage. This might reasonably have been expected since the alpha-particle tissue dosage undoubtedly increases with the amount of radium injected. However, the remaining four curves representing the rats sacrificed on the sixth, ninth, twelfth and fourteenth days, do not show a dependence on radium dosage greater than 20 μg. This is an unexpected dosage saturation effect which appears to indicate that the effect of radium which has been in the body for approximately six days or longer does not depend appreciably on the amount injected above 20 μg.

These observations lead to the conclusion that within a few days after injection the larger amounts of injected radium produce markedly greater effects in decreasing the total white cells, and that small doses of radium produce large decreases in white cells only after longer periods of time. The combined effect of both time and radium dosage does reach a maximum of about 80 percent decrease in white-cell count, and as this maximum is approached, either by increasing the initial quantity of radium or by allowing greater time to elapse, the other factor becomes much less effective.

In order to compare the RBE (relative biological effectiveness) of alpha particles with that of X-rays, the data of Suter ('48) on white cells have been plotted in a manner similar to that used in Figures 1 and 2. Rises are much steeper and his data show evidence of a recovery effect after the maximum drop in white-cell count is reached. These differences might well have been expected because of different rates of tissue irradiation. The X-ray dose was probably administered within a few minutes after which no more irradiation was received by the tissues. It is well known that the effectiveness of X-rays is greater for a given dose as the time of administration is shortened.



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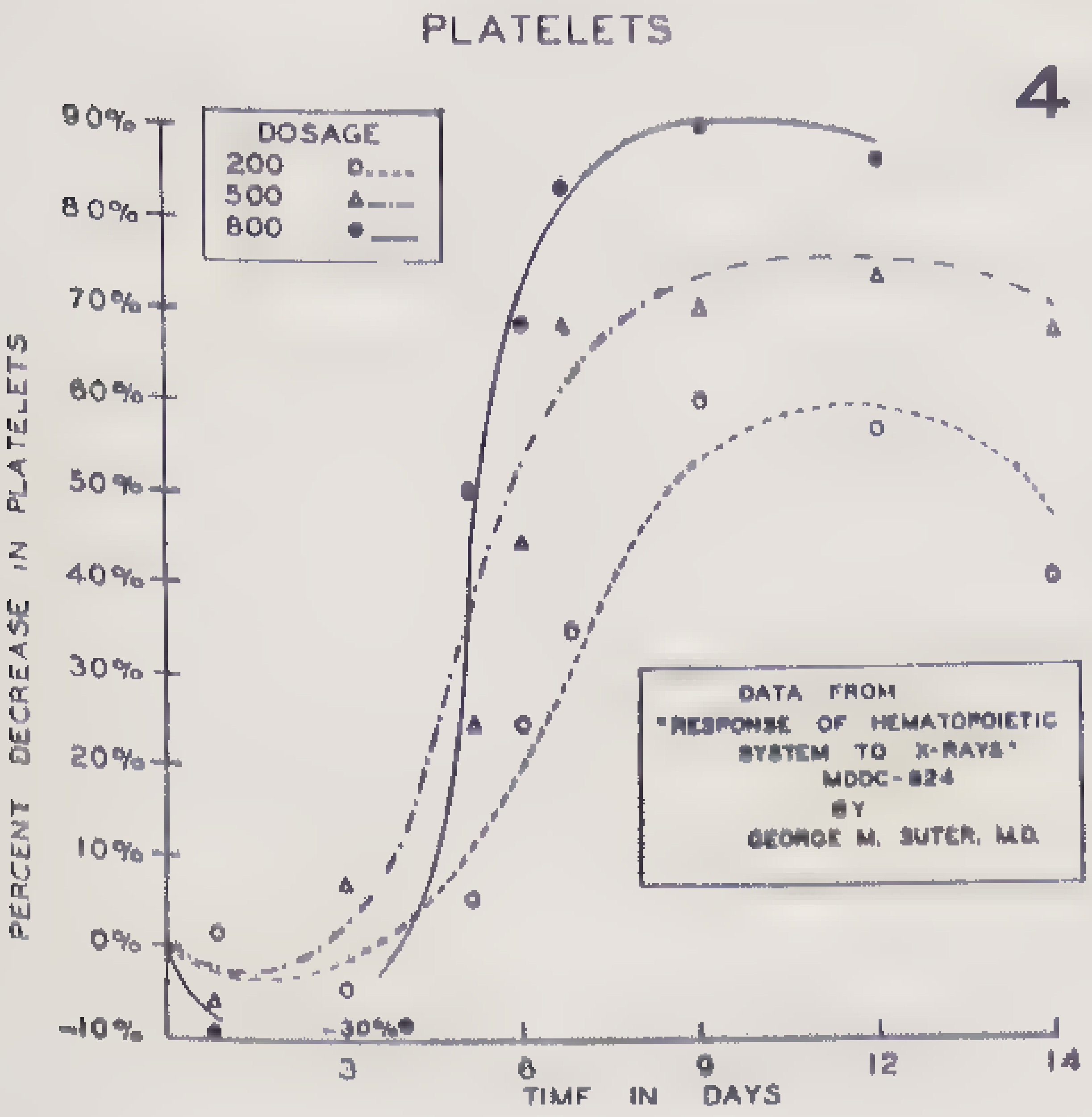
Blood Platelets

The data of Suter ('48) showing the percentage decrease in platelets for different X-ray doses have been plotted versus time in Figure 4. Our own data for different quantities of injected radium



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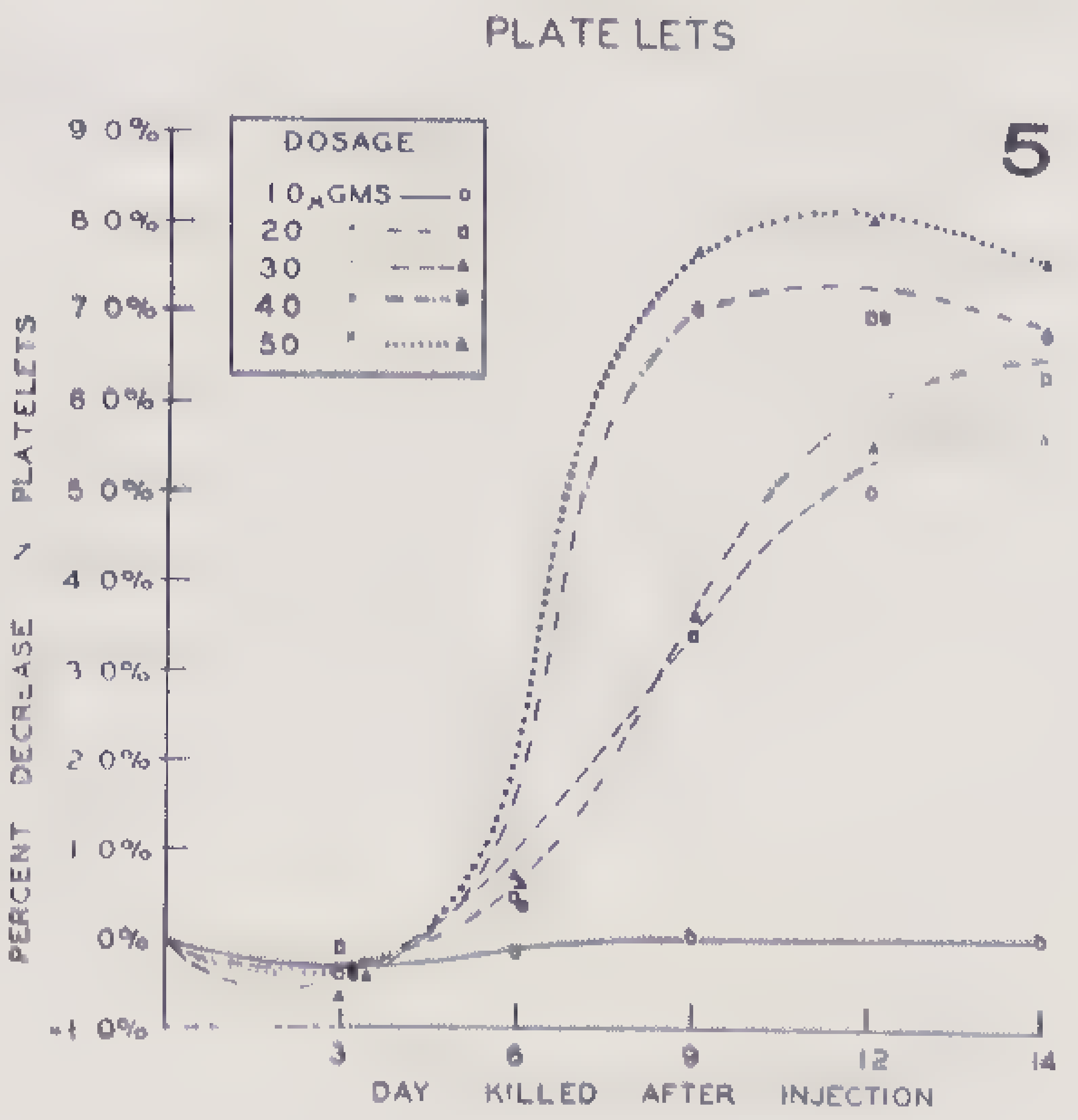

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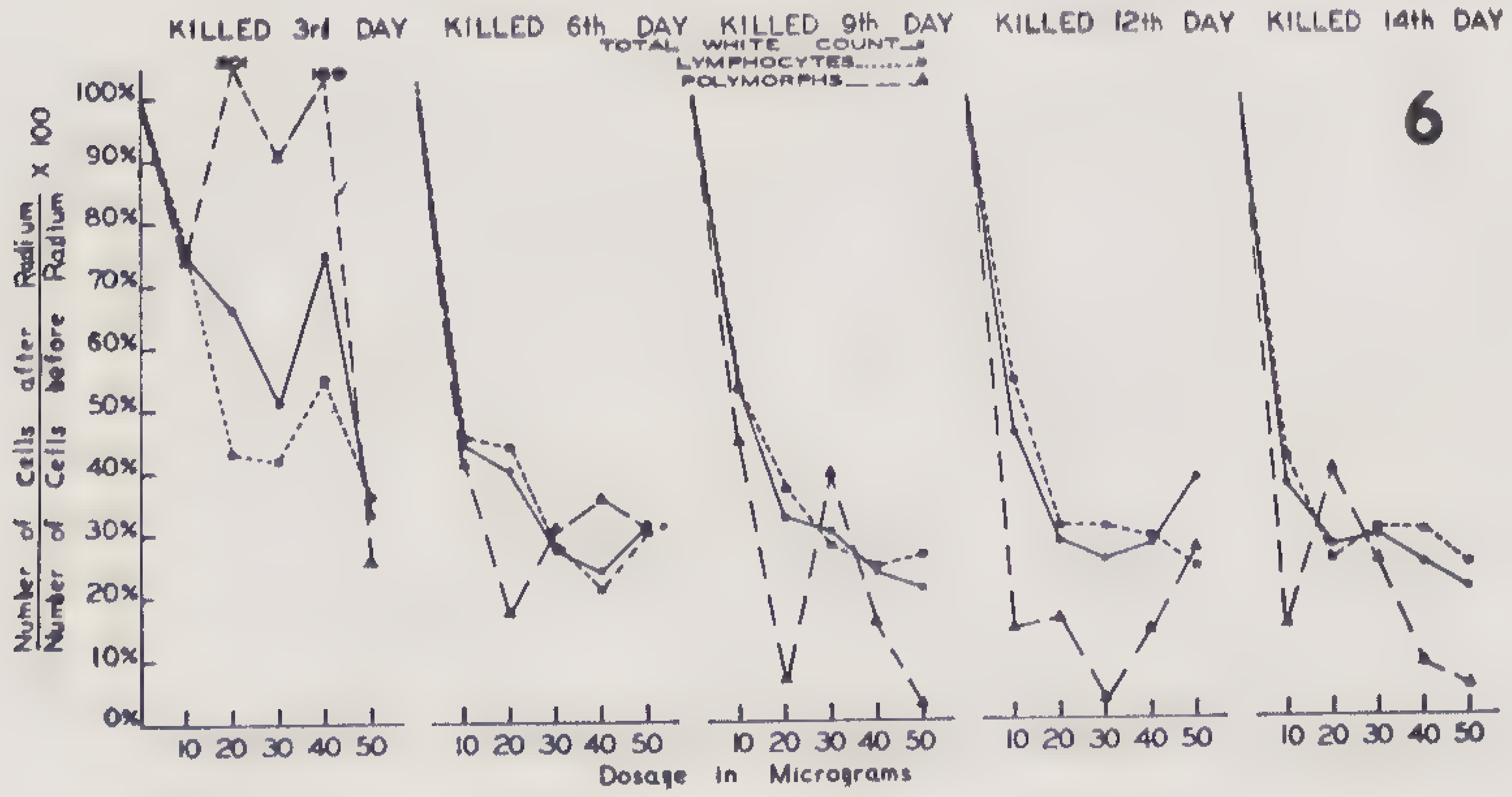
have been plotted in Figure 5, in a smilar manner in order to show the striking similarity in the effects of X-rays and radium on the platelet count. The curves are almost identical in form rising abruptly after three days to a maximum at very nearly nine days after injection. This apparent similarity in the behavior of the platelet count may furnish a basis for comparing the RBE of alpha-particle irradiation with that of X-rays.

It is observed in both figures 4 and 5 that the maximum of the curve is reached at approximately nine days. The curve for the 500 r X-ray dose reaches a maximum of 75 percent decrease in platelet count. From figure 5, it is seen that a 75 percent decrease would have been produced by a 40 microgram injection of radium in the same time.

Differential Sensitivity

Cantril, Jacobson & Nickson ('46) have reported a higher sensitivity of lymphocytes over polymorphs and they further state that this seems to be a well-established fact both for acute and chronic



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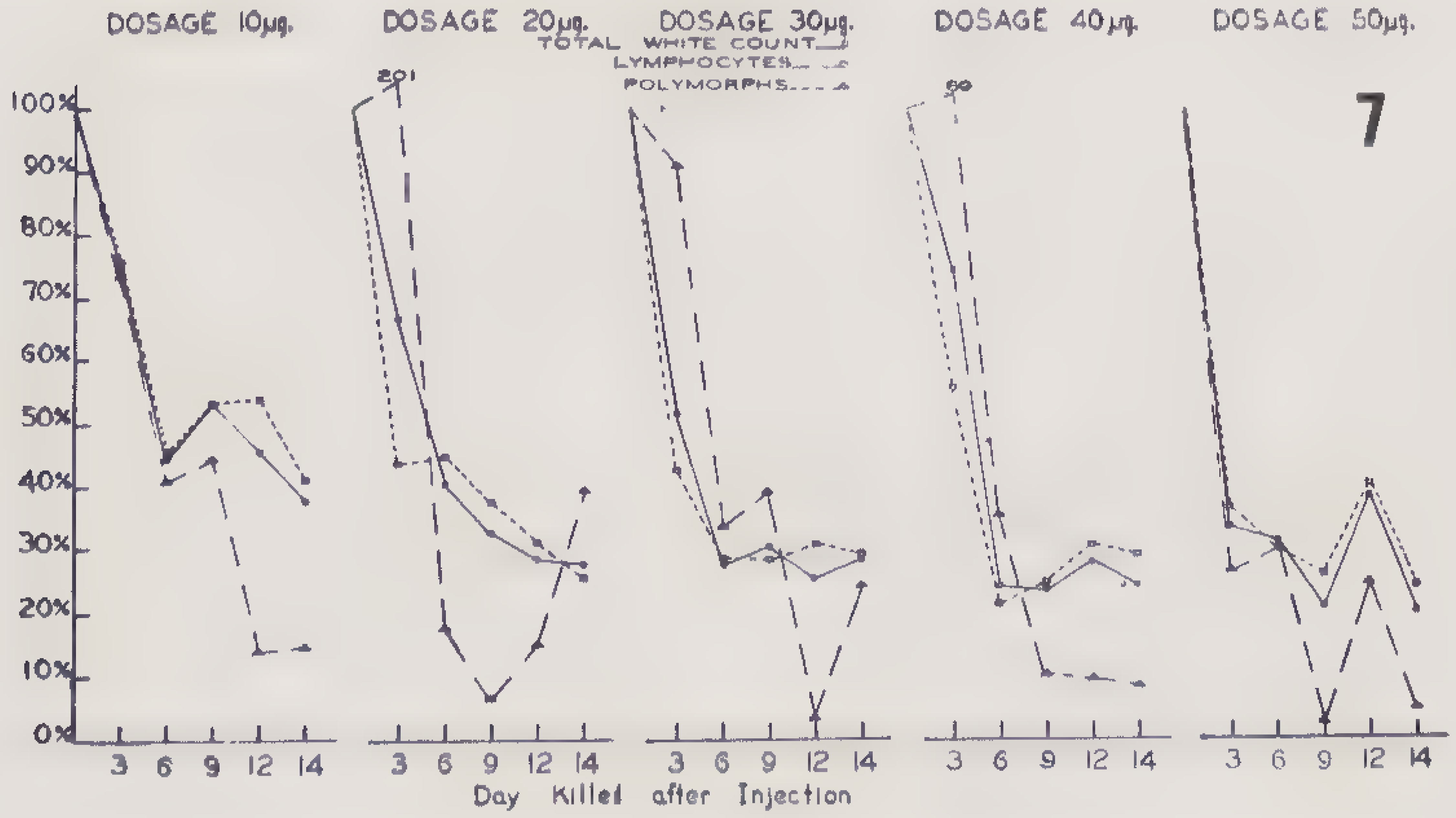

7

experiments. Graphically, Figures 6 and 7 do not illustrate this in our material. In Figure 6, time is constant and dosage variable. The opposite is true in Figure 7. With the exception of the third day, polymorphs show a slightly more sensitive condition than the lymphocytes when time is the constant factor. Where dosage is constant and time variable, the sensitivity of the polymorphs is even more pronounced. There are two slight rises of 201 percent and 169 percent for the polymorphs on the third day with dosages of 20 µg and 40 µg respectively. The average normal differential count for each rat was arbitrarily fixed as 100 percent. Any variation from this is expressed in percentage of the normal.

DISCUSSION

It seems to be agreed upon by all workers that the formed elements of the blood and their precursors are very sensitive to ionizing radiation. The degree of sensitiveness among them is different and different workers report conflicting results as to their degree of sensitivity. It is quite possible that the conditions of the experiments are not the same, especially the physiological state of the animals. A large factor must be considered when studying the loss of cells in the circulating blood. This factor is the rate of phagocytosis by the liver, spleen, lymph node, and bone marrow. Accurate studies must be carried out to determine the degree of injury of the white cells by radiation necessary to result in their phagocytosis. When these studies become standardized we can express a little more clearly the degree of sensitivity of any one of the formed elements of the blood. Until then we can only express quantitatively what is found in the periphery. The phagocytes of the body no doubt are injured also in the process of irradiation. This study in itself is a large field that should be investigated. Knisely ('48) and his co-workers have paved the way in the study of rates of phagocytosis under other experimental conditions. Another factor for consideration is the source of blood for study. Quimby, Saxon, and Goff ('48) have shown that the peripheral blood of the rat has three times as many white cells as heart blood. Roofe ('50) *et al.*, have shown also that this is true for the guinea pig. In this same paper, it was pointed out that the red-cell count was also higher at the periphery.

CONCLUSIONS

The total white-cell count is lowered appreciably by giving radium chloride (in varying dosages over a short period of time) intraperitoneally in young male albino rats. The polymorphs are slightly more sensitive than lymphocytes. Blood platelets are also sensitive, reacting a little more slowly, but when they do they show a pronounced drop.

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Studies on Kansas Mosses II

BY

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ABSTRACT: Eight taxa of mosses are added to the known flora of Kansas. This increases the total number of species to 154. The presence of the alpine and northern-inhabiting *Grimmia teretinervis* in Kansas is verified, and its remarkable distribution is discussed.

Field and herbarium studies made during the past four years have provided additional data concerning mosses little known in our flora, or not recorded in previous works. The more important taxa form the basis of this report.

Brotherella recurvans (Mx.) Fleisch. This moss, previously unknown from Kansas, has been collected on moist sandy banks in Leavenworth and Woodson counties. We have it from Leavenworth county, as Hartman 118, and from Woodson county as McGregor, Hartman, Showalter, and Roth, March 21, 1954, and Hartman 90. Grout (1932) gave the range of this taxon as from Newfoundland to Manitoba, Minnesota, Wisconsin, south in the Alleghanies to Georgia. Gier (1955) lists the taxon from Missouri as an unverified report from Shannon county in southeast Missouri. It thus appears that our collections extend the known range of this species considerably westward.

Diphyscium foliosum (Hedw.) Mohr. We have specimens of this taxon, as McGregor 11054, from Woodson county in southeast Kansas. The plants were found on barren banks in an open wooded sandy habitat dominated by *Quercus stellata.* Grout (1938) reports this taxon as common on shaded banks east of the Rocky Mountains. However, the nearest known station in our area was reported by Gier (1955) in east-central Missouri. Our collections extend the known range some 300 miles west in the plains area.

Grimmia olneyi Kindb. has been previously listed for Kansas as noted by McGregor (1950). However, specimen evidence was not known until March 21, 1954, when numerous clumps of the moss were found on sandstone outcrops in Woodson county. These are: Showalter 137 and Hartman 76. Grout (1933) gave the range as Nova Scotia to Ontario, south to Georgia. Gier (1955) listed the species from Missouri on the basis of a literature record, but he could not find specimen evidence. Our specimens seem to extend the known range of this taxon considerably westward.

Grimmia teretinervis Limpr. This taxon was little understood in North America until Kucyniak (1952) clarified its characteristics and distribution. This moss is well known in Europe where it occurs in alpine regions of Austria, Jugoslavia, Hungary and Switzerland. In the latter country it seems to be rather common. In North America the species is reported from Minnesota, Wisconsin and Quebec by Kucyniak (*loc. cit.*). Kucyniak also found herbarium specimens of the species from Kansas and Missouri. The first of these has questionable data, and therefore the record was provisional. The Missouri record was also reported as questionable.

The Kansas locality for *Grimmia teretinervis* was based upon a specimen in the New York Botanical Garden collected along Wolf's Creek, near Lucas, Russell county, Kansas on rocks, June 7, 1931, by C. H. Demetrio. Following the report of this collection by Kucyniak (1952), the senior author visited the Lucas locality and made collections of *Grimmia* species. One of these, McGregor 5672, was sent to Kucyniak for his study. He reported that the plant was certainly *G. teretinervis*, thus establishing unquestionably its presence in Kansas. Since then the taxon has been found in Scott county, as McGregor 2176 and from Norton county, as R. A. Keen, Sept. 1952.

The range of *Grimmia teretinervis* does not follow any general distribution pattern noted for other plants. It appears to be an alpine, nonarctic species which can occur at low altitudes, even sea level, where conditions of wind and other climatic factors somewhat duplicate alpine conditions.

In Kansas the species has been found in two different habitats. The Russell county station consists of calcareous sandstone escarpments along dry windswept hillslopes. The Scott and Norton county stations were crevices in calcareous conglomerates called mortar beds. These beds appear as outcrops along dry windswept cliffs.

Leptodictyum laxirete (Card. and Ther.) Broth. was found in a small creek five miles east of Baxter Springs, Cherokee county. Our specimens, Hartman 140, extend the known range of this taxon from Missouri to southeast Kansas.

Physcomitrium acuminatum (Schleich.) Bry. Eur. is here reported for the first time from Kansas on the basis of a specimen collected from Douglas county. This collection, Hartman 334, extends the known range of the taxon some 150 miles west from the nearest known station in Missouri.

Pogonatum pensilvanicum (Hedw.) Paris is added to the Kansas moss flora on the basis of collections by Elmer Roth, April 4, 1954, and Hartman 91, from a sandy bank near Sedan, Chautauqua county. This extends the range nearly 150 miles west from known stations in Missouri.

Polytrichum piliferum Hedw. has previously been reported from Kansas but without specimen evidence. It is now known by a collection, McGregor 5445, from a sandy hillside in Ellsworth county where it occurred near the base of *Andropogon gerardi* clumps.

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Notes on the Vegetation of Southeastern Mount Desert Island, Maine

BY

A. W. KÜCHLER

ABSTRACT: The vegetation of southeastern Mount Desert Island, Maine, was mapped at 1:25,000 and the physiognomy and floristic composition of each plant community recorded. For each species the coverage and sociability are given. These data are presented in tabular form with a brief comment explaining the methods employed and some observations made in the field.

INTRODUCTION

The field of vegetation mapping is rapidly evolving at the present time; in the course of this evolution, many problems become apparent and call for their solutions. In an attempt to contribute to these solutions, the writer investigated some relations between classifications of vegetation and purposes to which vegetation maps are applied.* In the summers of 1953 and 1954, the vegetation of southeastern Mount Desert Island, Maine, was mapped at a large scale, and colored maps at 1:25,000 have since been published.[1] It was exclusively with reference to the stated problems that this vegetation was mapped. The purpose of making these maps was *not* to make a phytosociological or an ecological study of the vegetation. However, it was quite inevitable that much detailed information on the vegetation should have been accumulated in the course of mapping it, even though such data were largely incidental to the ultimate purpose of the field work. These data are interesting in their own right, partly because they contribute to an understanding of the vegetation of the area, and partly because the vegetation is in rapid though very uneven evolution. These notes are therefore documents in the sense that they will be useful in the future, when the vegetation has passed through new stages of development. At any time, the study of the evolution of vegetation can be so much more meaningful if accurate details of some earlier period are available. Such details for present or future use are presented in this paper.

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* Sincere appreciation is expressed for the generous support given this project (N6onr 26006) by the Geography Branch of the Office of Naval Research, and for the cordial cooperation of the staff of Acadia National Park.

All species mentioned in this paper were identified by Dr. George B. Rossbach; the names are uniformly based on the 8th edition of *Gray's Manual of Botany* by M. L. Fernald. Doctor Rossbach deserves a special vote of thanks for his untiring enthusiasm and efficiency without which it would have been difficult to bring the field work to a successful conclusion.

[1] A. W. Küchler: Classification and Purpose in Vegetation Maps. *Geogr. Rev.*, vol. XLVI, No. 2, 1956.

Much of southeastern Mount Desert Island is located in Acadia National Park. This assures an evolution of the vegetation without appreciable interference by man, although some indirect effects are inevitable. For instance, the destruction by man of all large predators permits the increase of deer to a degree as to affect some features of the vegetation. But in general, the vegetation evolves before our eyes unhampered by lumbering or clearing. Not all of the area lies in Acadia National Park; lumbering is indeed carried on in restricted areas, and the comparison of the vegetational evolution on protected and on unprotected sites should add further value to the data embodied in this paper and to future studies of the vegetation of the island.

The same argument may be applied to the difference between the burned and the unburned sections of the region. The great Bar Harbor fire of 1947, which destroyed the vegetation of about twenty-three percent of the island was, of course, a real tragedy. But now that disaster has struck, the liability can be turned into an asset by making careful studies of the vegetation of the burned areas. It seems a great pity that no major effort was made to compile a detailed record of the regeneration of the vegetation year by year. The opportunity was singularly favorable but has been missed. The data here presented can remedy this situation only to a very minor degree, but their value in this respect is nevertheless beyond doubt.

This paper consists essentially of three parts: (1) An outline map of the vegetation of the area; (2) the detailed notes on the status of the vegetation as given in the "lists"; and (3) some observations on the vegetation, made during the field work.

The Map

The attached map of southeastern Mount Desert Island shows the outline of each vegetational area as first ascertained on large scale aerial photographs and later checked in the field.[1] Each area on the map has a number which corresponds to the same number in the "lists". Whereas the map accurately shows the outline of each vegetational unit, the detailed description of these units is given in the "lists".

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[1] A detailed description of the mapping method employed here has been given earlier: A. W. Küchler: A Comprehensive Method of Mapping Vegetation. *Ann. Assoc. Amer. Geogr.*, vol. XLV, No. 4. Dec. 1955.

The map served as a base map for the construction of the colored maps, referred to above. It has been printed on transparent paper and at the same scale (1:25,000) as the colored maps. A correlation between the material of this paper and the colored maps can be established by placing the outline map directly on the colored maps. Such a correlation enhances the value of both.

The Lists

The "lists" is a term which was established in the field as a matter of convenience; it is brief and clear. The material might have been referred to as a catalog, a record or even a table. While the data are, in a sense, tabulated or recorded, it can be said with equal justification that they are listed. And so the term "lists" was selected for the large collection of field records.

In these lists, the field data have been arranged in three different categories: (1) The numbers; (2) the physiognomic formulae; and (3) the floristic features.

A number precedes the description of every vegetational unit. The numbers were assigned to the areas only while the field investigation was in progress, which accounts for their irregular distribution on the map. Every number in the lists has its counterpart on the map.

The physiognomic formulae are based on the physiognomic classification of vegetation presented elsewhere by this author.[1,2] This classification is tabulated in an abbreviated form in Table 1. By arranging the various letter symbols into formulae, the physiognomy and structure of the vegetation can be described in great detail. An endless variety of combinations permits this flexible system to describe any conceivable type of vegetation. The reader is referred to the sources quoted for a detailed description of this system and its application, but two examples will here be given to illustrate the method.

For a first simple example, the reader is invited to turn to No. 96 in the lists; the formula is *Em Dlr L*. "*E*" stands for needleleaf ever-

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[1] A. W. Küchler: A Physiognomic Classification of Vegetation. *Ann. Assoc. Amer. Geogr.*, vol. XXXIX, No. 3, 1949. pp. 201-210.

[2] A. W. Küchler: Die Physiognomische Kartierung der Vegetation. *Pet. Geogr. Mitt.*, vol. 94, No. 1, 1950. pp. 1-6.

green trees, "*m*" means medium tall (10-25 m); "*D*" implies broadleaf deciduous trees, "*l*" refers to their low stature (less than 10 m), and "*r*" signifies rare but too conspicuous to be ignored. The lower case letters refer only to the capital nearest to the left, so that the "*l*" and the "*r*" refer only to the "*D*" but not to the "*E*". Finally, there is the "*L*" which stands for mosses or lichens. Therefore, the formula *Em Dlr L* is to be interpreted as follows: the vegetation consists of a forest of needleleaf evergreen trees of medium height; low broadleaf deciduous trees are thinly scattered through this forest and the forest floor has a cover of mosses or lichens.

TABLE 1.—*A physiognomic classification of vegetation*

CAPITAL LETTERS

Woody Vegetation:

B: evergreen broadleaf
D: deciduous broadleaf
E: evergreen needleleaf
N: deciduous needleleaf

Herbaceous Vegetation:

G: graminoids
H: forbs
L: lichens and mosses

SMALL LETTERS

Height:

t:	tall; minimum height of trees	25 m
	minimum height of herbaceous plants	2 m
m:	medium tall; height of trees	10- 25 m
	height of herbaceous plants	½- 2 m
l:	low; maximum height of trees	10 m
	maximum height of herbaceous plants	½ m
s:	shrubs; minimum height	1 m
z:	dwarf shrubs; maximum height	1 m

Density:

c: continuous growth
i: interrupted; plants usually do not touch
p: plants scattered singly, or in groves or patches
r: rare, yet conspicuous
b: barren; vegetation largely or entirely absent
w: aquatic vegetation

The second example may show a greater complexity, as illustrated by No. 13: *Dsz.lr Hmp Lp bp.* "*Ds*" stands for broadleaf deciduous shrubs (more than 1 m high) and "*Dz*" means broadleaf deciduous dwarf shrubs (less than 1 m). As both are broadleaf deciduous, they are contracted into "*Dsz*". The "*l*" signifies low trees (less than 10 m high) and "*r*" stands for rare but conspicuous. The lower case letters refer to the first capital at their left. As the "*r*" is to apply only to the "*l*", a period is placed between the "*l*" and the preceding letters. "*H*" means forbs, "*m*" is medium tall (½-2 m), and "*p*" implies patchy distribution. "*L*" stands for mosses or lichens and "*b*" signifies barren. The interpretation of the formula *Dsz.lr Hmp Lp bp* is therefore as follows: there is a stand of broadleaf deciduous shrubs and dwarf shrubs from which emerge occasional low broadleaf deciduous trees; patches of medium tall forbs and of mosses or lichens occur among the bushes as well as an appreciable number of barren spots.

The physiognomic formulae are followed by a description of the floristic composition of the vegetation with the major phytosociological data, coverage and sociability (*sensu* Braun-Blanquet[1]), given for each species listed. In every vegetational area, all species were listed if they were in any way prominent in their respective plant communities. If a species was represented by only one or very few specimens, its name was not included in the lists. The name of every species in the lists is followed by two numbers separated by a period. The first of these refers to the coverage and the second number refers to the sociability. The numerical values of the categories of each of these are given in Table 2.

TABLE 2

Coverage		*Sociability*	
+:	under 1% of the area	1:	species scattered singly
1:	1 - 5% of the area	2:	in small bunches or tufts
2:	5 - 25% of the area	3:	in patches
3:	25 - 50% of the area	4:	in larger groups
4:	50 - 75% of the area	5:	in extensive sheets
5:	over 75% of the area		

If, therefore, in the lists a species is given thus: *Osmunda cinnamomea* 2.3, then this is to be interpreted as follows: *Osmunda cinnamomea* covers 5-25% of the ground and grows in patches irregularly distributed throughout the area.

The vegetation as given in the lists has now been described in detail: (1) It is divided into a large number of distinct vegetation types; (2) the area (shape and extent) of each type is shown on the outline map; (3) the physiognomy and structure of each vegetation type is described in detail in the physiognomic formula; (4) the floristic composition (the species) of each type is given; (5) the coverage and the sociability are given for each listed species. The map and the lists are therefore an accurate record of the condition of the vegetation at the time of mapping.

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[1] J. Braun-Blanquet: *Pflanzensoziologie*. Springer Verlag, Wien, 1951.

Some Random Observations

The following observations, selected at random from the field notes, throw additional light on the conditions of the vegetation of Mount Desert Island. They were made quite incidentally to the mapping activities. For ecological studies and floras, the reader is referred to the literature.[1,2,3,4] The references given in the footnotes usually contain very adequate bibliographies for further research. Two maps of the vegetation of Mount Desert Island have become available in the past, one (unpublished) was prepared by the U. S. Forest Service, and one is published in the book by Moore and Taylor.[3] Both these maps are on small scales and hence much more generalized than the maps presented here and in the Geographical Review.[5]

The mapped area may well be divided into two parts: one part burned in the great Bar Harbor fire of 1947, and another part which escaped that calamity. However, the reader should not conclude that the vegetation was more or less uniformly destroyed in the burned area. Indeed, the variations in survival and revival are striking, ranging from one extreme to the other. There are "burned" areas where the effect of the fire was slight (191).* A few healing years and removal of the dead trees leave a vegetation which an unsuspecting tourist would not recognize as having burned at all. The other extreme shows tree stumps grotesquely crowning a set of stilt roots that rise from naked rock. Here the highly humous soil burned with the vegetation, and what remained of it was soon eroded and removed. The exposed granite is not conducive to a rapid recovery and only in small depressions and cracks has enough humus collected that flowering plants can once again participate in the seasonal rhythm of organic activity. The red spruce (*Picea rubens*), arbor vitae (*Thuja occidentalis*), and the white pine (*Pinus Strobus*) were usually destroyed so thoroughly that little or nothing remained of them. The pitch pine (*Pinus rigida*) proved more resistant and is the only conifer on Mount Desert Island able to produce root sprouts after a fire (127), but it did not do so very often. Beech (*Fagus grandifolia*) and oak (*Quercus rubra, var.*

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[1] A. F. Hill: The Vegetation of the Penobscot Bay Region, Maine, *Proc. Portland Soc. Nat. Hist.*, vol. 3, No. 3, 1923.

[2] F. Hyland and F. H. Steinmetz: *The Woody Plants of Maine.* University Press, Orono, Maine, 1944.

[3] B. Moore and N. Taylor: Vegetation of Mount Desert Island and Its Environment. *Brooklyn Bot. Garden Mem.*, 1927.

[4] E. T. Wherry: *Wild Flowers of Mount Desert Island, Maine.* Garden Club of Mount Desert Island, 1928.

[5] A. W. Küchler: Classification and Purpose of Vegetation Maps, *Geogr. Rev.*, vol. XLVI, No. 2, 1956.

* Numbers in parentheses refer to the same numbers in the lists.

borealis) were often able to survive because they could send strong sprouts from undamaged roots. This frequently resulted in very dense shrub formations. The grey birch (*Betula populifolia*) and the paper birch (*Betula papyrifera*) were almost invariably killed by the fire, but the wind scattered the readily available seed over the burned areas, and much of these is now clothed by a more or less dense cover of birches. Mixed with these are red maple (*Acer rubrum*), both aspens (*Populus tremuloides* and *P. grandidentata*), and the pin cherry (*Prunus pensylvanica*); the latter, in fact, is referred to as fire cherry because it colonizes burned areas so readily. Blueberries (*Vaccinium angustifolium*) and sweet fern (*Comptonia peregrina*) are also common on many of the burned sections. Due to circumstances, not investigated, the birch seedlings have already developed into little trees in some places whereas their growth is distinctly retarded elsewhere. Presumably, edaphic conditions are responsible for such an irregular development.

Conifers, quite generally, are slow in returning and certainly much slower than broadleaf deciduous trees. But the long root sprouts of beech and oak, and the fast growing birches and aspens often hide little conifers; the conifer seedlings seem scarcer than they are because they cannot be observed readily. But the fact remains, that they are also less numerous than other trees. The regeneration of larches on the burned areas is usually slight.

Many of the burned areas are very steep. The destruction of plant life and the resulting intensification of soil erosion has had the effect of making a mottled patchwork of the returning vegetation. The steeper slopes often remain barren whereas innumerable little ledges, or simply spots a little less steep and perhaps with cracks in the rock are once again covered with shrubs and forbs. Occasionally, the slopes are so steep that they are largely barren in any case. Trees that become established here escaped the fire because the latter could not reach them.

Sometimes, distinct plant communities endeavoring to re-establish themselves, do so without any clearly marked secondary succession, although some species are unable to return as quickly as others. For instance, a black spruce bog with the typically associated flora has returned, except for the black spruce (178). Similar examples can be given for cedar swamps (3).

The regeneration of the burned sections is now in full progress. Broadleaf deciduous trees and shrubs are taking over the entire area and are therefore much more prominent in the landscape than before the fire. Spruce, fir and pine seedlings appear among their faster growing companions but usually only in parts where they had been before the fire. While therefore birch, aspen, red maple and others have greatly extended their area, spruce, fir and pine have not. Beech and oak behave like the conifers in that they, too, do not expand into "new" territory. On the other hand, the great expansion of birch and aspen is obviously temporary; as the conifer seedlings mature, the light loving birches and aspens will disappear again.

Special mention must be made of some water relations. Where the soil permits ready drainage and seepage, and water may be assumed to move at an appreciable speed, as along streams in narrow valleys, hemlocks are a notable part of the vegetation (249); but they are never dominant. If the water moves more slowly or even seems to stagnate, a cedar (*Thuja occidentalis*) bog develops, or a black spruce (*Picea mariana*) bog. Larches are common in bogs, but more so in black spruce bogs than in others; while not limited to bogs, they are rare on the more mesic sites. Certain shrubs are commonly found in places where the water table may be assumed to be high, especially *Nemopanthus mucronata, Ilex verticillata, Viburnum cassinoides* and *Alnus spp.* Sometimes a wet spot accounts for the presence of these species in an otherwise mesic plant community (151).

On higher and often very rocky slopes, as especially on the upper western slopes of Mount Cadillac, water seeps along the surface of the granite. The result is invariably an accumulation of arbor vitae or white cedar (*Thuja occidentalis*). This species, incidentally, is the only one which reflects any zoological components of the biome: it is usually browsed by deer, sometimes heavily (131). The smaller plants form very dense bushes, whereas the trees have all their lower branches eaten off.

In the latitude and climate of Mount Desert Island, it may be assumed that there exists a sharp contrast between the north and south facing slopes of the mountains. This contrast is negligible. Pitch pine (*Pinus rigida*) occurs usually on well drained slopes of more or less southern exposure, but there is little else to indicate a climatic contrast between northern and southern exposures.

A special paragraph must be devoted to the summit type of vegetation, since it is largely responsible for the island's name. Champlain, sailing along the coast of Maine, was impressed with the absence of forests on the summits and therefore called the island "Isle des Monts Deserts"; this has been anglicized into Mount Desert Island. The summit type is rather clearly distinguishable. Although summits of most mountains are rather bare, they do not reach above the climatic timberline. This is well shown by the fact that the highest parts of the highest mountain, Mount Cadillac, have well developed forests of spruce and fir (46). The red spruce (*Picea rubens*) shows little or no effect of altitude, whereas the balsam fir (*Abies balsamea*) on Mount Cadillac presents the short and dense growth that is sometimes associated with altitudinal effects.

Although the summits show much barren ground, they are far from lifeless. Even very minor depressions contain a considerable variety of species, nearly all of which occur also at lower altitudes. The species that may be considered the most characteristic of higher elevations because they are limited to these sites, are quite insignificant in the general physiognomy of the vegetation. The most common of these species is *Arenaria groenlandica; Hypericum gentianoides* is rarer, and *Hudsonia ericoides* is found only sporadically. *Pinus Banksiana* occurs on Mount Cadillac, forming one very small grove (303).

The shore lines of an island may be expected to have a vegetation all their own. In the mapped area of Mount Desert Island, the coasts are very rocky, often cliff-like and the forest vegetation here does not seem to differ materially from forests farther inland. Indeed, it is remarkable how the forest will advance right to the edge of the salt water without appreciable change in physiognomy or floristic composition. The white spruce (*Picea glauca*) is perhaps the only one that shows a more or less distinct concentration near the coast, but it is by no means limited to the seashore. The very rockiness of some of the headlands results in vegetation types similar to equally rocky sites in the mountains with ground juniper (*Juniperus communis, var. depressa*) being representative. Species that are typical of and limited to the spray region of the sea cliffs are only few in number, notably *Solidago sempervirens* and *Juniperus horizontalis* (78). As a general rule, a coastal vegetation is not clearly developed.

The exception to the rule is a small beach of shell sand and its tiny hinterland. The beach itself is largely barren, but the grassy area behind it (21, 22) contains, among other species, *Ammophila breviligulata, Juncus balticus, var. littoralis,* and *Triglochin maritima* which are not found elsewhere in the mapped area of the island in appreciable quantity.

The vegetation of the lakes varies considerably in that some lakes show a varied and extensive development of plant communities whereas in others vegetation is notably absent. Of all the lakes, Aunt Betty Pond (171) and the Tarn (42) present quite the most spectacular sight when the water lilies (*Nymphaea alba*), the pickerel weed (*Pontederia cordata*) or the bladderwort (*Utricularia purpurea*) are in bloom. It may be said parenthetically that these "flowering lakes" are a real attraction in Acadia National Park, and quite unappreciated by the annual flood of tourists.

THE LISTS

1. Em Dlp Lp
   Picea rubens 5.1 Acer rubrum 1.1 Betula papyrifera 1.1 Acer pensylvanicum 1.1 Picea glauca +.1 moss spp. 2.3
2. Dsi Glp Hmlp bp
   Prunus pensylvanica 3.1 Acer rubrum 2.1 Alnus crispa, var. mollis 2.1 Betula populifolia 2.1 Betula papyrifera 1.1 Populus tremuloides 1.1 Populus grandidentata 1.1 Spiraea latifolia 1.1 Diervilla Lonicera 2.1 Rubus idaeus, var. strigosus 2.1 Poa compressa 1.3 Solidago canadensis 1.1 Solidago graminifolia 1.1
3. Gm Hlmp L
   Carex vulpinoidea? 2.2 Carex trisperma 2.2 Scirpus cyperinus, var. pelius 2.2 Calamagrostis canadensis 2.2 Typha latifolia 1.2 Juncus effusus, probably var. solutus 1.2 Solidago graminifolia 2.1 Onoclea sensibilis +.1 Dryopteris Thelipteris, var. pubescens +.2 Viola pallens? +.1 Eupatorium perfoliatum 1.1 Sphagnum sp. 5.5
4. Eml Dlr Hlr Lp
   Picea rubens 4.1 Thuja occidentalis 3.1 Abies balsamea 1.1 Acer rubrum 1.1 Betula papyrifera 1.1 Trientalis borealis 1.1 moss spp. 2.3
5. Dls Elr Hm
   Acer rubrum 5.1 Betula papyrifera 2.1 Fraxinus americana 1.1 Abies balsamea 2.1 Aster umbellatus 4.1
6. Dls.zp Emlp Hlp Bzp
   Acer rubrum 5.1 Betula papyrifera 2.1 Fraxinus americana 1.1 Abies balsamea 2.1 Picea rubens 1.1 Vaccinium angustifolium 1.2 Gaylussacia baccata 1.2 Pyrus melanocarpa +.1 Aster macrophyllus 3.4 Clintonia borealis 1.3 Pteridium aquilinum, var. latiusculum +.1 Aralia nudicaulis +.1 Aster acuminatus +.1 Kalmia angustifolia 2.3
7. Elp Dzp Lp
   Pinus rigida 4.1 Gaylussacia baccata 4.4 Amelanchier laevis +.1 Cladonia spp. 2.3
8. Dli Eli.mp Hlp
   Acer rubrum 3.1 Betula papyrifera 2.1 Betula populifolia 1.1 Populus grandidentata 1.1 Acer pensylvanicum 2.1 Picea rubens 2.1 Pinus Strobus 2.1 Abies balsamea 3.1 Maianthemum canadense 2.3 Aralia nudicaulis +.1 Aster macrophyllus +.2
9. El Dl.sp Hmlp
   Picea rubens 3.1 Abies balsamea 3.1 Pinus Strobus +.1 Betula papyrifera 2.1 Betula populifolia 1.1 Acer rubrum 2.1 Populus tremuloides 1.3 Viburnum cassinoides 1.1 Prunus pensylvanica +.1 Cornus

canadensis 2.4 Pteridium aquilinum, var. latiusculum 1.3 Aster umbellatus 1.1 Osmunda Claytoniana +.4 Osmunda cinnamomea +.4 Sphagnum spp. +.5

10. Eml Dlr Hlp Lp
Picea rubens 5.1 Abies balsamea 2.1 Thuja occidentalis 1.1 Picea glauca +.1 Betula papyrifera 1.1 Acer rubrum 1.1 Maianthemum canadense 1.3 Cornus canadensis 1.3 Trientalis borealis 1.3 moss spp. 4.4

11. Dls Emlr Hm [illegible]
Betula papyrifera 4.1 Acer rubrum 2.1 Fraxinus americana 2.1 Betula populifolia +.1 Acer spicatum 2.1 Sambucus pubens 1.1 Acer pensylvanicum 2.1 Populus tremuloides +.1 Rubus allegheniensis +.1 Picea rubens +.1 Abies balsamea +.1 Aster umbellatus 3.1 Maianthemum canadense 3.1 Aralia nudicaulis +.1 Solidago rugosa +.1 Cornus canadensis 1.2 Pteridium aquilinum, var. latiusculum +.1 Aster macrophyllus +.3

12. No symbols
urban and agricultural land

13. Dsz.lr Hmp Lp bp
Betula populifolia 3.1 Betula papyrifera 2.1 Populus tremuloides 2.1 Populus grandidentata 1.1 Acer rubrum 1.1 Prunus pensylvanica 1.1 Salix discolor +.1 Comptonia peregrina 1.2 Rubus allegheniensis 1.1 Vaccinium angustifolium 1.3 Aralia hispida +.1 Solidago bicolor 1.1 Aster macrophyllus +.2 Polytrichum sp. 3.3

14. Dls Hlp
Acer rubrum 3.1 Betula populifolia 2.1 Fraxinus americana 1.1 Populus tremuloides 1.1 Ilex verticillata +.1 Rubus pubescens 1.1 Osmunda Claytoniana 1.2 Solidago rugosa 1.1 Aster umbellatus 2.1

15. Ds Hlp
Alnus crispa, var. mollis 4.3 Spiraea latifolia 2.4 Solidago rugosa 2.3

16. Dls Elr Hml
Acer rubrum 3.1 Betula populifolia 2.1 Fraxinus americana 1.1 Prunus pensylvanica 2.1 Crataegus sp. 1.1 Thuja occidentalis 1.1 Solidago rugosa 3.3 Aster umbellatus 2.1

17. Eml
Picea glauca 4.1 Picea rubens 4.1 Abies balsamea 1.1

18. El Dsr Hli Glp L
Picea mariana 5.1 Ilex verticillata +.1 Osmunda cinnamomea 4.4 Smilacina trifolia +.2 Carex trisperma 1.3 Carex stricta 1.1 Calamagrostis canadensis 1.2 Sphagnum sp. 4.5

19. Dsp Hmlp Glp Lp
Acer rubrum 3.2 Betula populifolia 3.1 Calamagrostis canadensis +.1 Polytrichum sp. 4.3 in addition there are in: southern section: Rubus hispidus 3.4 Juncus tenuis +.3 Juncus canadensis +.2 Scirpus cyperinus, var. pelius +.2 Aster umbellatus +.1 northern section: Nemopanthus mucronata 1.3 Viburnum cassinoides +.1 Ilex verticillata +.1 Osmunda cinnamomea 1.3

20. Ds Gmp
Alnus rugosa, var. americana 4.1 Salix discolor 1.1 Calamagrostis canadensis 1.3

21. Gl Hlp Dzr
Ammophila breviligulata 5.5 Lathyrus japonicus, var. glaber 2.2 Lathyrus palustris +.4 Myrica pensylvanica +.4

22. Gl
Calamagrostis canadensis 3.4 Juncus Gerardi 1.4 Scirpus validus, var. creber 3.5 Juncus balticus, var. littoralis +.4 Hierochloe odorata 1.1 Triglochin maritima 1.4

23. wp
floating filamentous algae 3.5

24. Ds Hlp
Acer rubrum 2.1 Quercus rubra, var. borealis 2.1 Betula populifolia 2.1 Betula papyrifera 2.1 Populus tremuloides 2.1 Aster macrophyllus 1.3

25. Ds.zp Hlp Lp
Betula populifolia 3.1 Betula papyrifera 2.1 Comptonia peregrina 2.2 Acer rubrum 1.1 Populus tremuloides 1.1 Populus grandidentata 2.1 Prunus pensylvanica 1.1 Quercus rubra, var. borealis +.1 Pteridium aquilinum, var. latiusculum 1.1 Aralia hispida +.1 Danthonia spicata +.2 Polytrichum sp. 2.3

26. Ds Hlp
Quercus rubra, var. borealis 3.1 Acer rubrum 2.1 Betula papyrifera 2.1 Betula populifolia 2.1 Populus grandidentata 2.1 Populus tremuloides 1.1 Prunus pensylvanica +.1 Comptonia peregrina 2.2 Acer pensylvanicum +.1 Pteridium aquilinum, var. latiusculum +.1 Aster macrophyllus 1.2 Aralia hispida +.1 Lysimachia quadrifolia +.1 Danthonia spicata +.2 Polytrichum spp. +.3

27. Ds.zp
Quercus rubra, var. borealis 4.1 Betula papyrifera 2.1 Betula populifolia 1.1 Acer rubrum +.1 Acer pensylvanicum +.1 Comptonia peregrina 2.2

28. Dm.zp Hlp
Quercus rubra, var. borealis 5.1 Betula papyrifera 2.1 Acer rubrum +.1 Comptonia peregrina 1.2 Aster macrophyllus 2.4

29. Ds.mr
Quercus rubra, var. borealis 3.1 Betula papyrifera 3.1 Fagus grandifolia 2.1 Populus tremuloides 1.1 Acer pensylvanicum 1.1 Acer rubrum 1.1 Fraxinus americana +.1 Rubus allegheniensis 2.3

30. Dsz Hlp Lp
Quercus rubra, var. borealis 3.1 Betula papyrifera +.1 Betula populifolia 3.1 Acer rubrum 2.1 Populus grandidentata 1.1 Prunus pensylvanica 1.1 Populus tremuloides 1.1 Comptonia peregrina 2.2 Spiraea latifolia +.1 Aster macrophyllus 2.2 Aralia hispida +.1 Solidago canadensis +.1 Solidago Randii +.1 Solidago spp. +.1 Polytrichum sp. 1.3

31. Gm.wp
Typha latifolia 4.4 Sparganium chlorocarpum 1.3 Calamagrostis canadensis 2.4 Eleocharis palustris? +.2 Carex lenticularis +.2 Nulphar variegatum 2.3

32. Ds
Comptonia peregrina 3.3 Spiraea latifolia 3.3

33. Gl Dzp Elr
Danthonia spicata 4.5 other grass spp. 1.1 Antennaria neodioica +.1 Vaccinium angustifolium 1.1 Picea glauca 1.1

34. Dm.sp Elmr Hlp
Acer rubrum 3.1 Betula papyrifera 2.1 Quercus rubra, var. borealis 2.1 Populus tremuloides +.1 Picea rubens +.1 Picea glauca +.1 Pinus Strobus +.1 Thuja occidentalis +.1 Abies balsamea 1.1 Aster macrophyllus 2.3 Aster acuminatus +.2 Aralia nudicaulis +.2 Lysimachia quadrifolia 1.3 Pteridium aquilinum, var. latiusculum 1.3 Dryopteris Thelypteris, var. pubescens +.2

35. Ds.mlr Emlr Glr Hlr
Acer rubrum 2.1 Populus tremuloides 2.1 Betula papyrifera 1.1 Quercus rubra, var. borealis 1.1 Pinus Strobus 1.1 Comptonia peregrina 2.1 Salix discolor +.1 Prunus pensylvanica +.1 Rhus typhina +.1 Diervilla Lonicera +.2 Festuca rubra +.2 Danthonia spicata 1.2 Phleum pratense +.2 Agrostis alba or A. tenuis? +.2 Poa sp. +.2 Festuca capillata +.2 Aster macrophyllus 1.2

36. Dls Elp Hlr
Acer rubrum 3.2 Populus tremuloides 3.2 Betula populifolia 2.2 Abies balsamea 1.1 Aster macrophyllus 1.3

37. Gl Dlp Hlp
Phleum pratense 2.3 Festuca rubra 2.3 Dactylis glomerata 1.2 Poa pratensis 1.2 Anthoxanthum odoratum +.2 Ranunculus acris +.2 Pyrus malus (planted)

38. Elp Dlszpbp Hlp Glr Bzp Lp
Pinus rigida 2.1 Pinus Strobus 1.1 Betula papyrifera 1.1 Acer rubrum 1.1 Quercus rubra, var. borealis +.1 Prunus pensylvanica +.1 Vaccinium angustifolium 3.3 Diervilla Lonicera +.2 Pyrus melanocarpa +.2 Potentilla tridentata 1.3 Pteridium aquilinum, var. latiusculum 1.1 Deschampsia flexuosa +.2 Polytrichum sp. 1.3 lichen spp. 2.4 Danthonia spicata +.2 Kalmia angustifolia 2.3

39. Gl Dszp Hmlp
Festuca capillata 4.5 Agrostis alba? 3.2 Alnus crispa, var. mollis 2.1 Solidago spp. 1.1 Comptonia peregrina 2.2 Vicia Cracca 1.1 Aster umbellatus 1.1

40. Gl Dszp.lr Hlp
Festuca capillata 4.2 Agropyron repens 2.2 Spiraea latifolia 2.1 Prunus pensylvanica 2.1 Comptonia peregrina 2.1 Betula papyrifera 1.1 Betula populifolia 1.1 Vicia Cracca 1.1

41. Dml.szp Gmp
Acer rubrum 3.1 Betula papyrifera 2.1 Quercus rubra, var. borealis 2.1 Alnus rugosa, var. americana +.2 Myrica Gale 3.4 Calamagrostis canadensis 1.4

42. w
Nuphar variegatum 3.4 Najas flexilis 3.5 Nymphaea odorata 2.3 Pontederia cordata 2.3 Utricularia purpurea 1.4 Sparganium fluctuans +.4

43. Dmsi Emr Hmlp
Acer rubrum 3.1 Betula papyrifera 2.1 Fraxinus americana 1.1 Betula populifolia 1.1 Fagus grandifolia 1.1 Betula lutea 1.1 Quercus rubra, var. borealis 1.1 Populus tremuloides 1.1 Prunus pensylvanica +.1 Acer pensylvanicum +.1 Sambucus canadensis 2.1 Sambucus pubens 2.1 Rubus allegheniensis 3.4 Rubus idaeus, var. strigosus 3.4 Acer spicatum +.1 Tsuga canadensis 1.1 Dryopteris noveboracensis +.3 Osmunda Claytoniana +.2 Solidago rugosa +.1 Aralia nudicaulis 1.1 Aster macrophyllus +.3

44. Gm Hmlp Dszp
Calamagrostis canadensis 5.5 Carex spp. 2.3 Impatiens capensis 1.2 Lysimachia terrestris 1.3 Salix discolor and probably S. gracilis 3.2 Populus tremuloides +.1 Betula populifolia +.1

45. Dzp Eszp Glp Bzr Hlr Lp bp
Vaccinium angustifolium 2.3 Betula populifolia +.1 Nemopanthus mucronata +.1 Pyrus melanocarpa +.1 Picea rubens +.1 Juniperus communis, var. depressa +.2 Abies balsamea +.1 Deschampsia flexuosa 1.2 Arctostaphylos Uva-ursi, var. coactilis +.1 Kalmia angustifolia 1.1 Potentilla tridentata +.3 Arenaria groenlandica 1.3

46. El Dsp Hlp
Picea rubens 4.1 Abies balsamea 3.1 Betula papyrifera 2.1 Viburnum cassinoides 1.1 Nemopanthus mucronata 1.1 Vaccinium angustifolium +.1 Kalmia angustifolia +.1 Pyrus americana +.1 Cornus canadensis 1.3 Aralia nudicaulis +.1

47. Dml.sp Elp.mr Hlp
Acer rubrum 3.1 Betula papyrifera 3.1 Fagus grandifolia 1.1 Fraxinus americana 1.1 Acer pensylvanicum 1.1 Picea rubens 1.1 Pinus Strobus 1.1 Tsuga canadensis +.1 Abies balsamea 2.1 Maianthemum canadense 1.1 Pteridium aquilinum, var. latiusculum 2.3 Aralia nudicaulis 1.1 Aster macrophyllus 1.1 Dennstaedtia punctilobula 1.4

48. Dls.mp Emlp Hmlp Glp
Betula papyrifera 2.1 Acer rubrum 2.1 Betula populifolia 2.1 Populus grandidentata 1.1 Viburnum cassinoides 1.1 Prunus pensylvanica 1.1 Acer pensylvanicum 1.1 Spiraea latifolia 1.1 Diervilla Lonicera 1.2 Picea rubens 2.1 Thuja occidentalis 1.1 Pinus Strobus +.1 Aster macrophyllus 2.5 Aster umbellatus 1.1 Vaccinium angustifolium +.3 Pteridium aquilinum, var. latiusculum +.3 Danthonia spicata 1.2 Deschampsia flexuosa 1.2 Cladonia spp. +.3

49. Dml.sp Emlp Hmlp Gmp Lp
Acer rubrum 4.1 Betula papyrifera 2.1 Fraxinus americana 1.1 Betula lutea 1.1 Acer pensylvanicum 2.1 Picea rubens 2.1 Abies balsamea +.1 Aralia nudicaulis 1.1 Ilex verticillata 1.1 Alnus rugosa, var. americana 1.1 Nemopanthus mucronata 1.1 Thuja occidentalis 1.1 Osmunda Claytoniana 1.3 Cornus canadensis 1.3 Calamagrostis canadensis 1.3 moss spp. 3.3

50. Dls Elr bp
Acer rubrum 3.1 Betula papyrifera 3.1 Quercus rubra, var. borealis 1.1 Fraxinus americana 1.1 Picea rubens +.1 Thuja occidentalis +.1

51. Em Dlszr Hlr Lp
Picea rubens 5.1 Acer rubrum +.1 Betula papyrifera +.1 Acer pensylvanicum 1.1 Vaccinium angustifolium +.2 Aralia nudicaulis +.1 Maianthemum canadense +.1 Pteridium aquilinum, var. latiusculum +.2 moss spp. 3.3

52. b

53. Eml Dlp
Picea rubens 4.1 Betula papyrifera 2.1 Acer rubrum 2.1 Acer pensylvanicum 2.1

54. Dml Hmlp
Betula papyrifera 3.1 Betula lutea 3.1 Acer rubrum 2.1 Acer pensylvanicum 3.1 Acer saccharum 1.1 Dryopteris marginalis +.1 Dryopteris spinulosa +.1 Osmunda Claytoniana +.1 Athyrium Filix-femina, var. Michauxii? 2.1

55. Dlsp Elp bp
Betula papyrifera 3.1 Acer rubrum 2.1 Acer pensylvanicum +.1 Acer spicatum +.1 Diervilla Lonicera +.1 Picea rubens 2.1 Thuja occidentalis 2.1

56. Dl Emp
Betula papyrifera 3.1 Acer rubrum 2.1 Acer saccharum 2.1 Acer pensylvanicum 2.1 Betula lutea 1.1 Picea rubens 2.1 Tsuga canadensis +.1

57. Dzi Hlp Glp Lp bp
Betula populifolia 3.3 Populus tremuloides 3.3 Vaccinium angustifolium 2.3 Aralia hispida 1.1 Anaphalis margaritacea, var. intercedens +.2 Solidago graminifolia +.1 Danthonia spicata +.2 Deschampsia flexuosa 2.2 moss spp. 2.3

58. Dls Elr
Acer rubrum 3.1 Fraxinus americana 2.1 Betula papyrifera 2.1 Fagus grandifolia +.1 Acer pensylvanicum 2.1 Picea rubens 1.1

59. Dms Hlp
Fagus grandifolia 3.1 Acer saccharum 3.1 Betula lutea 2.1 Fraxinus americana +.1 Betula papyrifera +.1 Acer pensylvanicum 2.1 Polystichum acrostichoides +.1 Dryopteris spinulosa +.1

60. Dz.sp Glp Hlp Lp
Betula populifolia 3.1 Vaccinium angustifolium 3.3 Populus grandidentata 1.1 Prunus pensylvanica 1.1 Acer pensylvanicum +.1 Deschampsia flexuosa 2.3 Danthonia spicata 2.3 Pteridium aquilinum, var. latiusculum 1.1 Aralia hispida +.1 lichen spp. 1.3 moss spp. 2.3

61. Emp Dmp
Tsuga canadensis 3.1 Picea rubens 1.1 Acer rubrum 3.1 Acer saccharum 1.1 Betula papyrifera 1.1

62. Eml Dlszp Hlp L
Picea rubens 4.1 Thuja occidentalis 2.1 Pinus Strobus 1.1 Abies balsamea 1.1 Betula papyrifera 1.1 Acer rubrum 1.1 Acer pensyl-

vanicum 1.1 Cornus canadensis 1.1 Pteridium aquilinum, var. latiusculum 2.1 Maianthemum canadense 1.1 Vaccinium angustifolium 2.4 moss spp. 4.3 lichen spp. 3.3

63. Ds Elp Hm Lp
Betula populifolia 4.4 Vaccinium angustifolium 1.3 Thuja occidentalis 2.1 Aster umbellatus 5.4 Polytrichum sp. 3.3 Sphagnum sp. 1.2 lichen spp. 1.2

64. Ds.li Hmlp
Acer rubrum 3.1 Betula papyrifera 2.1 Fagus grandifolia 2.1 Betula populifolia 2.1 Acer pensylvanicum 1.1 Populus grandidentata 1.1 Rubus idaeus, var. strigosus 2.3 Solidago canadensis +.1 Solidago rugosa +.1 Aralia hispida +.3

65. El Dlp Gmlp Hmlp Lp
Thuja occidentalis 5.1 Betula populifolia 1.1 Calamagrostis canadensis 1.3 Carex crinita +.2 Aster umbellatus 1.1 moss spp. 1.3

66. Eml Dlzp Hlp Lp
Picea rubens 4.1 Thuja occidentalis 1.1 Betula papyrifera 2.1 Acer rubrum 1.1 Vaccinium angustifolium 1.3 Cornus canadensis 1.3 Pteridium aquilinum, var. latiusculum 1.3 Maianthemum canadense 1.3 moss spp. 2.2

67. Dml.sp Emr
Acer rubrum 3.1 Betula papyrifera 2.1 Fagus grandifolia 2.1 Betula lutea 1.1 Acer saccharum 1.1 Acer pensylvanicum 3.1 Tsuga canadensis 1.1

68. Dml Emlp Hli Lp
Betula papyrifera 4.1 Acer rubrum 2.1 Populus grandidentata +.1 Acer pensylvanicum 2.1 Picea rubens 2.1 Pinus Strobus 1.1 Thuja occidentalis 1.1 Abies balsamea 2.1 Pteridium aquilinum, var. latiusculum 2.1 Aralia nudicaulis 2.1 Cornus canadensis 1.1 Trientalis borealis +.1 Aster macrophyllus 2.1 Maianthemum canadense 1.1 moss spp. 2.3

69. Emli Dmlsi Hmlp
Picea rubens 2.1 Abies balsamea 2.1 Pinus Strobus 2.1 Betula papyrifera 4.1 Acer rubrum 1.1 Acer pensylvanicum 1.1 Aralia nudicaulis 1.1 Aster macrophyllus 1.1 Pteridium aquilinum, var. latiusculum 1.1

70. Dmp Emlp
Betula papyrifera 3.1 Acer rubrum 2.1 Acer pensylvanicum 1.1 Pinus Strobus 3.1 Thuja occidentalis 1.1

71. Dlszp Elp Glp Lp bp
Betula populifolia 1.1 Betula papyrifera +.1 Acer rubrum +.1 Gaylussacia baccata 1.3 Vaccinium angustifolium 1.2 Pyrus melanocarpa 1.3 Picea rubens +.1 Thuja occidentalis +.1 Deschampsia flexuosa 1.2 lichen spp. 2.3

72. Dm Elr Glp
Fagus grandifolia 4.1 Betula lutea 2.1 Betula papyrifera 2.1 Acer saccharum 1.1 Acer pensylvanicum 1.1 Picea rubens 1.1 Carex conoidea? 1.2

73. Em Dlr
Thuja occidentalis 5.1 Picea mariana 1.1 Pinus Strobus 1.1 Acer rubrum 1.1

74. Dzp Elsr Lp Bzr Glr bp
Gaylussacia baccata 1.1 Pyrus melanocarpa +.1 Vaccinium angustifolium +.2 Rhododendron canadense 1.1 Nemopanthus mucronata +.2 Kalmia angustifolia 1.1 Thuja occidentalis +.1 Picea rubens +.1 lichen spp. 2.3 Deschampsia flexuosa +.2 Danthonia spicata +.2 Arenaria groenlandica +.1 Potentilla tridentata +.1

75. El Dlszp Lr bp
Picea rubens 5.1 Thuja occidentalis 1.1 Betula papyrifera 1.1 Acer rubrum 1.1 Vaccinium angustifolium 1.3 Gaylussacia baccata +.3 Kalmia angustifolia +.3 lichen spp. 1.2

76. Emli Dlp Hlp
Abies balsamea 2.1 Picea rubens 2.1 Pinus Strobus 1.1 Betula papyrifera 1.1 Betula populifolia +.1 Acer rubrum 1.1 Cornus canadensis +.4 Maianthemum canadense 1.2 Pteridium aquilinum, var. latiusculum +.2 Aralia nudicaulis +.1 Clintonia borealis +.1

77. Dsz.lp Elzr Hmp Glp Lp bp
Viburnum cassinoides 2.1 Prunus pensylvanica 1.1 Betula papyrifera 1.1 Betula populifolia 1.1 Prunus virginiana 1.1 Populus tremuloides +.1 Myrica pensylvanica 2.4 Diervilla Lonicera 1.1 Rubus allegheniensis 2.1 Picea glauca 1.1 Juniperus communis, var. depressa 1.3 Danthonia spicata 2.2 Solidago canadensis 1.1 lichen spp. 2.3 Pteridium aquilinum, var. latiusculum 1.1 Aster macrophyllus 1.3 Aster umbellatus 1.1

78. Glp Dzp Ezp.lr Hlr bp
Festuca rubra 3.3 Festuca capillata +.3 Myrica pensylvanica 1.3 Spiraea latifolia 1.1 Juniperus communis, var. depressa 2.3 Juniperus horizontalis +.3 Picea glauca 1.1 Aster novi-belgii, probably var. litoreus +.1 Plantago juncoides, var. decipiens +.2 Solidago nemoralis 1.1 Solidago sempervirens +.1

79. Emp Dlp Hlp
Picea rubens 4.1 Picea glauca +.1 Abies balsamea 1.1 Acer rubrum 3.1 Acer pensylvanicum +.1 Betula papyrifera 2.1 Aster macrophyllus 1.3 Aralia nudicaulis +.1 Maianthemum canadense 1.2

80. Eml Dlsp Lp
Picea rubens 4.1 Abies balsamea +.1 Thuja occidentalis 1.1 Pinus Strobus +.1 moss spp. 3.3 Acer rubrum 2.1 Betula papyrifera 1.1 Acer pensylvanicum +.1

81. Eml Dlr
Picea rubens 5.1 Pinus Strobus 1.1 Abies balsamea +.1 Thuja occidentalis +.1 Acer rubrum +.1

82. Dmlp Elp Hmp Glr
Acer saccharum 2.1 Acer rubrum 2.1 Fraxinus americana 2.1 Thuja occidentalis 3.1 Aster umbellatus 3.1 Osmunda Claytoniana 2.3 Osmunda regalis, var. spectabilis 2.3 Osmunda cinnamomea 2.3 Carex gracillima 2.2

83. Dl
Acer rubrum 4.1 Betula papyrifera 3.1 Acer saccharum +.1 Fagus grandifolia +.1

84. Elp Dlszp Lp bp
Picea rubens 4.1 Thuja occidentalis 2.1 Pinus resinosa 1.1 Betula papyrifera 1.1 Acer rubrum 1.1 Vaccinium angustifolium 1.3 Gaylussacia baccata 1.3 Kalmia angustifolia +.3 Pteridium aquilinum, var. latiusculum +.3 lichen spp. 2.3

85. Emli Dlp Hlp Lp
Picea rubens 4.1 Pinus Strobus +.1 Tsuga canadensis +.1 Betula papyrifera 2.1 Acer rubrum 2.1 Populus grandidentata +.1 Maianthemum canadense 1.1 Cornus canadensis +.1 Aralia nudicaulis +.1 moss spp. 3.2

86. Elp Dlszp Bzp Glp Lp bp
Picea rubens 2.1 Betula populifolia 2.1 Acer rubrum +.1 Gaylussacia baccata 2.3 Vaccinium angustifolium 1.3 Pyrus melanocarpa 1.3 Kalmia angustifolia 1.2 Danthonia spicata 1.2 Deschampsia flexuosa 1.2 Cladonia spp. 1.3

87. Dzp Bzp Hlp Glp Lp bp
Pyrus melanocarpa 4.3 Gaylussacia baccata 1.3 Vaccinium angustifolia 2.2 Kalmia angustifolia 1.3 Potentilla tridentata +.1 Arenaria groenlandica +.2 Deschampsia flexuosa 1.2 Cladonia spp. 2.3

88. Dm Emr
Fagus grandifolia 4.1 Betula papyrifera 1.1 Acer saccharum 1.1 Acer rubrum +.1 Betula lutea +.1 Fraxinus americana +.1 Tsuga canadensis +.1

89. Dm.lsp Emlr
Betula papyrifera 3.1 Acer saccharum 1.1 Acer rubrum 3.1 Fagus grandifolia 2.1 Betula lutea +.1 Fraxinus americana +.1 Quercus rubra, var. borealis +.1 Acer pensylvanicum 1.1 Acer spicatum +.1 Tsuga canadensis +.1 Abies balsamea +.1 Picea rubens +.1 Pinus Strobus +.1

90. Emp Dlszp Hmp Glp
Picea rubens 2.1 Tsuga canadensis +.1 Pinus Strobus 1.1 Acer rubrum 3.1 Betula papyrifera 2.1 Betula populifolia 2.1 Acer pensylvanicum 1.1 Amelanchier laevis +.1 Vaccinium angustifolium 3.3 Aster umbellatus 1.1 Pteridium aquilinum, var. latiusculum 2.2 Danthonia spicata 2.3 Deschampsia flexuosa 2.3

91. Emli Dlszi Glp Lr
Picea rubens 2.1 Pinus Strobus 3.1 Thuja occidentalis 1.1 Betula papyrifera 3.2 Betula populifolia 2.1 Acer pensylvanicum 2.1 Acer rubrum 2.1 Vaccinium angustifolium 4.3 Gaylussacia baccata 2.3 Danthonia spicata 1.2 Deschampsia flexuosa 3.3 lichen spp. 1.3

92. Dl.zr Elr
Acer saccharum 3.1 Betula papyrifera 3.1 Fagus grandifolia 2.1 Betula lutea 2.1 Acer pensylvanicum 1.1 Picea rubens 1.1 Rubus idaeus, var. strigosus 1.4

93. Dzp Bzp Elp Hlp Glr bp
Pyrus melanocarpa 2.1 Vaccinium angustifolia +.2 Vaccinium Vitis-Idaea, var. minus +.2 Kalmia angustifolia 2.2 Picea rubens 1.1 Deschampsia flexuosa +.2 Potentilla tridentata 1.2 Arenaria groenlandica +.2 Rhododendron canadense +.2

94. Dli.sp Elr Hmp Gmp
Acer rubrum 4.4 Betula populifolia 1.1 Viburnum cassinoides 1.1 Nemopanthus mucronata 1.1 Alnus crispa, var. mollis 1.1 Pyrus americana +.1 Picea rubens 1.1 Aster umbellatus 3.1 Brachyelytrum erectum, var. septentrionale +.3 Calamagrostis canadensis 3.4 Carex gracillima 2.2

95. Dml.sp Emlp Hlp Glp
Acer rubrum 4.1 Betula populifolia 3.1 Acer pensylvanicum 2.1 Viburnum cassinoides 1.1 Picea rubens 3.1 Abies balsamea +.1 Picea glauca +.1 Pteridium aquilinum, var. latiusculum +.1 Aster umbellatus 1.1 Calamagrostis canadensis 2.4 Carex gracillima 2.2 Brachyelytrum erectum, var. septentrionale 2.4

96. Em Dlr L
Picea rubens 5.1 Pinus Strobus +.1 Thuja occidentalis +.1 Betula papyrifera +.1 Acer rubrum +.1 moss spp. 4.3

97. Dl El Hlp Lr
Betula papyrifera 3.1 Acer rubrum 3.1 Acer pensylvanicum 1.1 Picea rubens 2.1 Picea glauca 1.1 Abies balsamea 3.1 Maianthemum canadense 2.4 moss spp. 1.2 lichen spp. 1.3

98. Eml Dlp.sr Hlp
Picea rubens 5.1 Pinus Strobus 2.1 Abies balsamea 1.1 Betula papyrifera 1.1 Acer rubrum 1.1 Acer pensylvanicum 1.1 Maianthemum canadense 1.2 Aralia nudicaulis +.1 Trientalis borealis +.1

99. Dml Elr
Fagus grandifolia 4.1 Betula papyrifera 2.1 Acer rubrum 1.1 Betula lutea 1.1 Acer pensylvanicum 1,1 Picea rubens 1.1

100. Dml Elp Hmlp
Acer rubrum 4.1 Betula papyrifera 2.1 Betula lutea 1.1 Fraxinus americana 1.1 Picea rubens 2.1 Abies balsamea 1.1 Dryopteris noveboracensis +.3 Aster macrophyllus 1.1 Osmunda Claytoniana 1.1 Dryopteris Phegopteris +.1

101. Gl Dzp
Carex lenticularis 2.2 Carex rostrata 2.2 Carex stricta 2.2 Dulichium arundinaceum 2.2 Typha latifolia 2.2 Myrica Gale 1.2 Alnus rugosa, var. americana 1.2 Nemopanthus mucronata 1.2 Ilex verticillata 1.2

102. Dz.lsp Glp Hmp Emzr
Spiraea latifolia 2.2 Diervilla Lonicera 2.2 Vaccinium angustifolium 2.3 Acer rubrum 1.1 Gaylussacia baccata 1.3 Betula papyrifera 2.1 Viburnum cassinoides +.1 Prunus pensylvanica +.1 Betula populifolia +.1 Festuca rubra 1.2 Danthonia spicata 1.2 Aster umbellatus 1.1 Pteridium aquilinum, var. latiusculum 1.3 Solidago graminifolia +.1 Picea rubens 2.1 Juniperus communis, var. depressa +.2 Picea glauca 1.1

103. Em Dlp Nlr Hmp
Picea rubens 5.1 Abies balsamea 1.1 Acer rubrum 2.1 Acer pensylvanicum 1.1 Betula papyrifera 1.1 Betula lutea 1.1 Larix laricina +.1 Kalmia angustifolia +.3 Osmunda Claytonia +.2 Osmunda cinnamomea 1.2

104. Dz.lr Elp Bzp Glp Lp Hmlp bp
Picea rubens 3.1 Pinus Strobus 1.1 Picea glauca 1.1 Vaccinium angustifolium 4.3 Gaylussacia baccata 3.3 Betula papyrifera 2.1 Acer rubrum 2.1 Kalmia angustifolia 1.2 Danthonia spicata 2.3 Deschampsia flexuosa 1.3 Pteridium aquilinum, var. latiusculum 3.3 Cladonia spp. 2.3

105. El Hl Glp L
Thuja occidentalis 5.1 Picea rubens +.1 Osmunda cinnamomea 4.4 Carex trisperma 2.2 Equisetum sylvaticum, forma multiramosum 1.3 Sphagnum spp. 4.4

106. Em.lp Lp Hlr
Picea rubens 5.1 Maianthemum canadense 1.1 moss spp. 3.3

107. Eml Hlp Lp Dzp.mlr
Picea rubens 5.1 Abies balsamea 1.1 Cornus canadensis 2.1 Maianthemum canadense 2.1 moss spp. 3.3 Betula papyrifera 1.1 Acer rubrum 1.1 Gaylussacia baccata +.2 Vaccinium angustifolium +.2

108. Gl Ezlr Dzr Hmr
Festuca rubra 4.4 Luzula multiflora 2.3 Festuca capillata 2.3 Anthoxanthum odoratum 1.3 Juniperus communis, var. depressa +.1 Picea glauca +.1 Spiraea latifolia 2.3 Alnus crispa, var. mollis +.2 Hypericum perforatum +.2

109. Em
Picea rubens 5.1 Pinus Strobus 2.1

110. Emli Dlzp Hlp Glp Lp bp
Picea rubens 3.1 Thuja occidentalis 2.1 Pinus rigida +.1 Betula papyrifera 1.1 Acer rubrum 2.1 Gaylussacia baccata 2.4 Vaccinium angustifolium 2.4 Aster umbellatus +.3 Pteridium aquilinum, var. latiusculum 1.3 Danthonia spicata 1.2 Deschampsia flexuosa 1.2 lichen spp. 1.2

111. Dm.sp Emr
Acer rubrum 2.1 Betula papyrifera 2.1 Betula lutea 2.1 Fagus grandifolia 2.1 Acer saccharum 1.1 Acer pensylvanicum 3.1 Picea rubens 1.1 Pinus Strobus +.1

112. Elp.zr Dzp Bzp Glp Lp Hlr bp
Picea rubens 2.1 Pinus rigida 1.1 Juniperus communis, var. depressa +.2 Gaylussacia baccata 2.2 Betula populifolia +.1 Vaccinium angustifolium 1.2 Pyrus melanocarpa 1.2 Rhododendron canadense 1.1 Kalmia angustifolia 2.2 Deschampsia flexuosa 1.2 Danthonia spicata 1.2 Cladonia spp. 2.3 Potentilla tridentata +.2 Hypericum gentianoides +.2 Hudsonia ericoides 1.1

113. Eli.zr Dzp Glr Bzr bp
Picea rubens 3.1 Pinus rigida 1.1 Juniperus communis, var. depressa +.2 Pinus resinosa 1.1 Gaylussacia baccata 2.2 Vaccinium angustifolium 2.2 Betula populifolia +.1 Deschampsia flexuosa +.1 Danthonia spicata +.2 Kalmia angustifolia 1.2

114. Dl Elp
Acer rubrum 3.1 Betula papyrifera 3.1 Picea rubens 2.1

115. Not on map.

116. Dml Elp Hlp
Betula papyrifera 4.1 Acer rubrum 3.1 Acer saccharum 1.1 Acer pensylvanicum 1.1 Betula lutea 1.1 Populus grandidentata 1.1 Fraxinus americana 1.1 Thuja occidentalis 2.1 Picea rubens 2.1 Dryopteris noveboracensis +.2 Aralia nudicaulis +.1

117. Dls Elp.mr Nlr
Acer rubrum 3.1 Betula papyrifera 2.1 Betula populifolia 2.1 Fraxinus americana 2.1 Alnus rugosa, var. americana 2.1 Amelanchier laevis 2.1 Ilex verticillata 2.1 Pinus Strobus 2.1 Abies balsamea +.1 Larix laricina 1.1

118. Eml Hlp
Picea glauca 5.1 Thuja occidentalis +.1 Abies balsamea +.1 Maianthemum canadense 2.4 Aralia nudicaulis +.1

119. Dml Eml
Acer saccharum 2.1 Fagus grandifolia 2.1 Betula lutea 2.1 Betula papyrifera 1.1 Acer rubrum 1.1 Fraxinus americana 1.1 Picea rubens 3.1 Abies balsamea 2.1 Picea glauca 1.1 Pinus Strobus 1.1

120. Eml Dlzr Hlp
Pinus Strobus 4.1 Picea rubens 2.1 Thuja occidentalis +.1 Abies balsamea +.1 Acer rubrum +.1 Betula papyrifera +.1 Vaccinium angustifolium 1.3 Maianthemum canadense 1.3 Gaylussacia baccata 1.3

121. Eml Dlp Hlp
Picea rubens 4.1 Thuja occidentalis 1.1 Abies balsamea 1.1 Betula papyrifera 2.1 Acer rubrum 2.1 Betula lutea 1.1 Aster macrophyllus 1.2 Aster umbellatus 1.2 Maianthemum canadense 1.1 Cornus canadensis 1.1 Aralia nudicaulis 1.1

122. Em.lp Dlsr
Picea rubens 5.1 Abies balsamea 1.1 Thuja occidentalis +.1 Betula papyrifera 1.1 Acer pensylvanicum 2.1

123. Dz Gl L Hmlp
Myrica Gale 5.1 Vaccinium Oxycoccos 1.1 Chamaedaphne calyculata, var. angustifolia +.1 Rosa nitida +.1 Carex stricta 4.1 Carex sp. 1.1 Carex lenticularis 4.1 Sphagnum spp. 5.5 Aster nemoralis +.2 Pogonia ophioglossoides +.1 Osmunda regalis, var. spectabilis +.1

124. Ds Elp Nlr Hlp Glp
Alnus crispa, var. mollis 3.3 Acer rubrum 1.1 Ilex verticillata 1.1 Nemopanthus mucronata 1.1 Thuja occidentalis 1.1 Larix laricina +.1 Smilacina trifolia 1.1 Carex spp. 1.2

125. El Dlr Hmp L
Thuja occidentalis 5.1 Acer rubrum +.1 Osmunda cinnamomea 3.4 Sphagnum spp. 4.4 moss spp. 1.3

126. Ds.zp Glp Hlr
Populus tremuloides 3.1 Betula populifolia 3.1 Prunus pensylvanica 1.1 Acer rubrum +.1 Quercus rubra, var. borealis 1.1 Comptonia pere-

grina 1.2 Carex spp. 2.3 Lysimachia quadrifolia +.3 Aster macrophyllus +.3

127. Dsi.zp Hlp Glr Ezr Lp bp
Betula papyrifera 3.1 Acer rubrum 1.1 Quercus rubra, var. borealis 1.1 Betula populifolia 1.1 Prunus pensylvancia 1.1 Diervilla Lonicera 1.2 Comptonia peregrina 3.2 Vaccinium angustifolium 2.3 Aralia hispida 1.1 Pteridium aquilinum, var. latiusculum 1.1 Danthonia spicata 1.2 Pinus rigida 1.1 Polytrichum sp. 3.2

128. Dm.lp Elp.mr
Acer saccharum 3.1 Fagus grandifolia 3.1 Betula papyrifera 1.1 Betula lutea 1.1 Acer pensylvanicum 1.1 Tsuga canadensis 1.1 Picea rubens 1.1 Abies balsamea 1.1

129. Eli Dszp Lp
Picea rubens 4.1 Pinus rigida 1.1 Betula populifolia 1.1 Gaylussacia baccata 2.3 Vaccinium angustifolium 2.3 Lichen spp. 2.3

130. Dls Elp
Betula papyrifera 3.1 Betula populifolia 3.1 Prunus pensylvanica 1.1 Amelanchier laevis 1.1 Picea rubens 2.1 Abies balsamea 1.1 Thuja occidentalis +.1

131. Dszp Bzp Ezr Glr bp
Pyrus melanocarpa 2.2 Vaccinium angustifolium 2.2 Betula populifolia 1.1 Potentilla tridentata 2.2 Kalmia angustifolia 2.2 Juniperus communis, var. depressa +.1 Thuja occidentalis +.1 Festuca capillata +.3 Danthonia spicata 1.3 Deschampsia flexuosa +.3

132. Dsz Hlp Gmlp Lp
Betula populifolia 4.1 Diervilla Lonicera 2.2 Prunus pensylvanica 1.2 Spiraea latifolia 1.2 Betula papyrifera +.1 Aster umbellatus 1.1 Pteridium aquilinum, var. latiusculum +.1 Lysimachia quadrifolia +.2 Danthonia spicata 1.2 Deschampsia flexuosa 2.2 Calamagrostis canadensis 1.2 Polytrichum sp. 2.2

133. bp Emlp Dlzp Bzr Lp
Picea rubens 3.1 Thuja occidentalis +.1 Betula populifolia 1.1 Betula papyrifera +.1 Vaccinium angustifolium 2.3 Kalmia angustifolia 1.3 Potentilla tridentata +.2 Abies balsamea +.1 Cladonia spp. 2.3

134. Emi Dzp.lsr Glp Hlp
Picea rubens 5.1 Abies balsamea 1.1 Betula populifolia +.1 Viburnum cassinoides +.1 Vaccinium angustifolium 2.2 Deschampsia flexuosa 1.3 Cornus canadensis 2.4

135. Dml.szp Elr Hmlp Glr
Betula papyrifera 3.1 Fagus grandifolia 2.1 Betula populifolia 1.1 Acer saccharum 1.1 Acer rubrum 3.1 Fraxinus americana +.1 Betula lutea +.1 Acer pensylvanicum 2.1 Abies balsamea +.1 Aster umbellatus 2.1 Solidago rugosa 1.2 Aster macrophyllus 1.3 Onoclea sensibilis 1.2 Osmunda Claytoniana +.1 Dryopteris noveboracensis +.3 Solidago canadensis +.1 Carex crinita +.2

(Dslzp Glp Hlp Elr: forest openings in No. 135)
Betula populifolia 2.1 Acer pensylvanicum 2.1 Comptonia peregrina 2.2 Vaccinium angustifolium 2.3 Rubus allegheniensis 2.1 Rubus idaeus,

var. strigosus 2.1 Danthonia spicata 2.3 Deschampsia flexuosa 2.3 Pteridium aquilinum, var. latiusculum 2.1 Aster umbellatus 1.1 Solidago canadensis 1.1 Picea rubens 1.1

136. Dl.sp.mr Hlp Glp Elr
Betula papyrifera 3.1 Acer rubrum 3.1 Acer saccharum 2.1 Acer pensylvanicum 2.1 Prunus pensylvanica 2.1 Aster umbellatus 2.1 Spiraea latifolia 1.2 Poa compressa 1.2 Deschampsia flexuosa 1.2 Pinus Strobus 2.1 Picea rubens 2.1 Thuja occidentalis 1.1 Festuca capillata 1.2

137. Dli Elp Hlp Glp Dsp
Betula populifolia 3.1 Betula papyrifera 1.1 Acer rubrum 2.1 Acer saccharum 1.1 Acer pensylvanicum 1.1 Prunus pensylvanica 1.1 Rubus allegheniensis 1.1 Thuja occidentalis 2.1 Pinus Strobus 1.1 Picea rubens 1.1 Aster umbellatus 1.2 Danthonia spicata +.1 Festuca capillata +.1 Poa compressa +.1

138. Eml Dmlzp Hli
Picea rubens 5.1 Pinus Strobus 2.1 Abies balsamea +.1 Betula papyrifera 1.1 Acer rubrum 1.1 Acer pensylvanicum +.1 Vaccinium angustifolium 3.3 Aralia nudicaulis 1.1 Cornus canadensis 2.1 Maianthemum canadense 1.1 Pteridium aquilinum, var. latiusculum 3.3

139. Em Dlszp Hlp
Picea rubens 3.1 Pinus Strobus 2.1 Picea glauca 1.1 Abies balsamea 1.1 Acer rubrum 2.1 Betula populifolia 1.1 Betula papyrifera 1.1 Vaccinium angustifolium 1.2 Gaylussacia baccata 1.2 Aralia nudicaulis 1.1 Pteridium aquilinum, var. latiusculum 2.4 Cornus canadensis 1.3 Maianthemum canadense 1.1

140. Eml
Picea rubens 4.1 Picea glauca 1.1 Thuja occidentalis 2.1

141. Dls Hm Elr Nlr
Acer rubrum 2.1 Betula populifolia 2.1 Fraxinus americana 1.1 Ilex verticillata 1.1 Alnus rugosa, var. americana 3.1 Aster umbellatus 3.2 Onoclea sensibilis 2.2 Lysimachia terrestris 2.2 Osmunda Claytoniana 1.2 Osmunda cinnamomea 1.2 Solidago rugosa 1.1 Thuja occidentalis 1.1 Abies balsamea 1.1 Larix laricina 1.1

142. Dl.szp Elr Hmlp Glp
Quercus rubra, var. borealis 3.1 Acer rubrum 2.1 Betula populifolia 2.1 Comptonia peregrina 2.3 Vaccinium angustifolium 2.3 Gaylussacia baccata 2.3 Pinus rigida 1.1 Aralia nudicaulis 1.1 Pteridium aquilinum, var. latiusculum 2.3 Danthonia spicata 2.2

143. Em Hlp Dlzr
Picea rubens 4.1 Pinus Strobus 3.1 Abies balsamea 1.1 Aralia nudicaulis +.2 Pteridium aquilinum, var. latiusculum 1.2 Cornus canadensis +.2 Maianthemum canadense +.2 Acer rubrum +.1 Vaccinium angustifolium +.2 Gaylussacia baccata +.2

144. Dzp Bzp Hlp Glp Lp bp
Gaylussacia baccata 1.3 Vaccinium angustifolium 2.2 Kalmia angustifolia 1.3 Arenaria groenlandica +.2 Potentilla tridentata +.2 Deschampsia flexuosa 2.2 Cladonia spp. 2.3

145. Dz.sp Glp
Betula populifolia 4.1 Populus grandidentata 1.1 Acer rubrum +.1 Vaccinium angustifolium 3.4 Acer pensylvanicum +.1 Danthonia spicata +.1 Deschampsia flexuosa 3.4

146. Dml Hmlp Glp
Acer rubrum 5.1 Quercus rubra, var. borealis +.1 Fraxinus americana 1.1 Acer saccharum 1.1 Fagus grandifolis +.1 Betula papyrifera 1.1 Acer pensylvanicum +.1 Aster umbellatus 3.3 Pteridium aquilinum, var. latiusculum +.1 Brachyelytrum erectum, var. septentrionale 1.2

147. Dml.sr Elp Hmlp
Acer rubrum 3.1 Quercus rubra, var. borealis +.1 Betula papyrifera 3.1 Betula populifolia +.1 Amelanchier laevis +.1 Acer pensylvanicum +.1 Abies balsamea 3.1 Picea rubens 1.1 Pteridium aquilinum, var. latiusculum 1.2 Aster umbellatus +.1 Cornus canadensis 1.1 Maianthemum canadense 1.1

148. Dsz.lp Elr Glp Hlp
Betula populifolia 3.1 Betula papyrifera 3.1 Populus grandidentata 2.1 Fraxinus americana +.1 Populus tremuloides +.1 Salix discolor +.1 Acer rubrum +.1 Vaccinium angustifolium 1.3 Comptonia peregrina 2.2 Pinus Strobus +.1 Picea rubens +.1 Festuca rubra 1.3 Pteridium aquilinum, var. latiusculum +.3 Solidago graminifolia +.3 Solidago rugosa 2.3 Aralia hispida +.2

149. Eml Nlp Hmlp Glp Lp Dzr
Thuja occidentalis 4.1 Picea mariana +.1 Pinus Strobus +.1 Larix laricina 1.1 Osmunda regalis, var. spectabilis +.2 Osmunda cinnamomea +.2 Onoclea sensibilis +.1 Potentilla simplex, var. calvescens +.1 Solidago graminifolia +.1 Aster umbellatus +.1 Aster radula +.1 Viola pallens? +.1 Carex spp. 1.2 Carex cephalantha? 2.3 Calamagrostis canadensis 2.4 Sphagnum spp. 3.3 Rubus idaeus, var. strigosus +.3

150. Dsz Hlp Elr
Betula populifolia 3.1 Betula papyrifera 3.1 Populus grandidentata 2.1 Acer rubrum +.1 Populus tremuloides +.1 Comptonia peregrina 2.2 Vaccinium angustifolium 1.3 Aralia hispida +.2 Pteridium aquilinum, var. latiusculum +.3 Pinus Strobus +.1 Picea rubens +.1

151. Gmlp Hmlp Elp Dmlsr
Anthoxanthum odoratum 2.3 Agrostis tenuis? 2.2 Danthonia spicata 2.2 Festuca capillata 1.2 Panicum sp. 1.3 Carex crinita 3.3 Carex projecta? +.2 Carex vulpenoidea? +.2 Poa palustris +.1 Glyceria striata 1.3 Impatiens capensis +.2 Solidago rugosa +.3 Solidago canadensis 1.2 Hieracium floribundum +.1 Hieracium aurantiacum +.1 Hieracium pratense +.3 Hieracium Pilosella +.1 Picea rubens 1.1 Picea glauca +.1 Thuja occidentalis +.1 Betula populifolia +.1 Betula lutea +.1 Fraxinus americana +.1 Rubus idaeus, var. strigosus +.3

152. Dmi.sp Elr Gmlp Hmlp
Quercus rubra, var. borealis 2.1 Acer rubrum 2.1 Betula populifolia 2.1 Betula papyrifera 1.1 Fraxinus americana 3.1 Abies balsamea +.1 Picea rubens +.1 Anthoxanthum odoratum 1.3 Agrostis alba or A.

tenuis? 1.2 Panicum sp. +.3 Danthonia spicata 1.2 Festuca capillata +.2 Solidago rugosa +.3 Solidago canadensis 1.2 Hieracium pratense +.3 Hieracium floribundum +.1 Hieracium Pilosella +.1 Hieracium aurantiacum +.1

153. Dz.sr Glp Hlp
Betula papyrifera 4.1 Populus grandidentata +.1 Quercus rubra, var. borealis +.1 Acer rubrum 1.1 Salix discolor +.1 Vaccinium angustifolium 2.3 Comptonia peregrina 2.2 Danthonia spicata 1.3 Pteridium aquilinum, var. latiusculum 1.1 Aralia hispida +.1

154. Dls.zp Hli Glp
Quercus rubra, var. borealis 5.1 Acer rubrum +.1 Fagus grandifolia +.1 Betula papyrifera +.1 Vaccinium angustifolium +.2 Gaylussacia baccata +.2 Pteridium aquilinum, var. latiusculum 4.1 Danthonia spicata 1.2

155. Dlzi.sp Elp Glp
Betula populifolia 4.1 Betula papyrifera 2.1 Acer rubrum 2.1 Populus grandidentata 1.1 Acer pensylvanicum +.1 Vaccinium angustifolium 3.4 Picea rubens 2.1 Deschampsia flexuosa 3.4 Danthonia spicata +.1

156. Ds.mli Elr Hlp Glp
Acer rubrum 3.1 Fagus grandifolia 2.1 Betula papyrifera 2.1 Betula lutea 1.1 Acer saccharum 1.1 Acer pensylvanicum 2.1 Fraxinus americana 1.1 Rubus idaeus, var. strigosus 3.3 Tsuga canadensis 1.1 Dryopteris noveboracensis 1.2 Danthonia spicata 2.1

157. Ds.mp Glp Hlp Elr
Betula papyrifera 2.1 Betula populifolia 1.1 Acer rubrum 1.1 Quercus rubra, var. borealis +.1 Populus tremuloides 1.1 Rubus idaeus, var. strigosus 1.2 Calamagrostis canadensis 1.3 Brachyelytrum erectum, var. septentrionale 1.3 Pteridium aquilinum, var. latiusculum +.2 Dryopteris noveboracensis +.3 Viola incognita? +.2 Trientalis borealis +.1 Thuja occidentalis +.1

158. El Dlr Hml L Nlr Glp
Thuja occidentalis 5.1 Picea mariana +.1 Acer rubrum +.1 Osmunda cinnamomea 3.3 Osmunda regalis, var. spectabilis 3.3 Sphagnum spp. 4.4 Trientalis borealis +.1 Gaultheria hispidula +.2 Coptis groenlandica 1.2 Carex trisperma 1.3 Larix laricina 1.1

159. Eml Dlsp.mzr Lp
Picea rubens 3.1 Abies balsamea 2.1 Thuja occidentalis 2.1 Pinus Strobus 3.1 Fagus grandifolia 2.1 Acer saccharum 1.1 Acer rubrum 2.1 Quercus rubra, var. borealis 1.1 Acer pensylvanicum 2.1 Fraxinum americana 1.1 Betula papyrifera 1.1 Populus grandidentata +.1 Vaccinium angustifolium 1.2 moss spp. 1.3 lichen spp. 1.3

160. Dmls Emlp
Fagus grandifolia 2.1 Betula papyrifera 2.1 Acer rubrum 2.1 Acer pensylvanicum 1.1 Acer spicatum 1.1 Betula lutea 1.1 Picea rubens 2.1 Abies balsamea 2.1

161. Eml Dlr
Picea rubens 3.1 Pinus Strobus 3.1 Thuja occidentalis 1.1 Pinus resinosa 1.1 Abies balsamea 1.1 Betula papyrifera 1.1

162. Dlsz Emp
Acer rubrum 3.1 Quercus rubra, var. borealis 1.1 Betula populifolia 3.1 Populus tremuloides 1.1 Comptonia peregrina 1.2 Pinus Strobus 2.1 Picea rubens 1.1

163. Dl.mzp Elp Hmlp Glp
Quercus rubra, var. borealis 4.1 Acer rubrum 1.1 Betula populifolia 1.1 Vaccinium angustifolium 3.3 Pteridium aquilinum, var. latiusculum 3.1 grass spp. 3.3 Pinus Strobus 2.1 Picea rubens 1.1

164. Dl.zp Elp Hlr
Betula populifolia 4.1 Acer rubrum 1.1 Vaccinium angustifolium 3.3 Gaylussacia baccata 1.3 Abies balsamea 2.1 Picea rubens 1.1 Pteridium aquilinum, var. latiusculum +.3

165. Dls
Fagus grandifolia 4.1 Betula papyrifera 1.1 Acer rubrum 2.1 Quercus rubra, var. borealis 1.1 Acer pensylvanicum 1.1 Hamamelis virginiana +.1

166. Glwp
Sparganium chlorocarpum 1.3

167. Dz.sp.lr Gmlp Elr
Chamaedaphne calyculata, var. angustifolia 3.3 Myrica Gale 3.3 Calamagrostis canadensis 1.3 Carex stricta +.2 Alnus rugosa, var. americana +.1 Nemopanthus mucronata +.2 Ilex verticillata 1.2 Viburnum cassinoides +.1 Betula populifolia +.3 Acer rubrum +.1 Picea mariana +.1

168. Dz.sp Hlr
Betula populifolia 4.1 Comptonia peregrina 3.2 Betula papyrifera 1.1 Acer rubrum 1.1 Populus grandidentata 1.1 Prunus pensylvanica +.1 Aralia hispida 1.2

169. Dsz.lp Emr Hmp
Betula populifolia 3.1 Comptonia peregrina 3.2 Acer rubrum 3.1 Quercus rubra, var. borealis 1.1 Spiraea latifolia +.1 Salix discolor +.1 Vaccinium angustifolium 3.3 Pinus Strobus 1.1 Pteridium aquilinum, var. latiusculum 2.1

170. Dz Glp Lp
Betula populifolia 5.1 Comptonia peregrina 2.3 Vaccinium angustifolium 1.2 Acer rubrum +.1 Festuca capillata 2.4 Festuca rubra +.1 Agrostis tenuis? 1.3 Danthonia spicata +.2 Polytrichum sp. 2.4

171. wp Hlp Glp
Nymphaea odorata 2.4 Nuphar variegatum +.2 Eleocharis Smallii? 1.3 Brasenia Schreberi +.3 Pontederia cordata +.3 Sparganium chlorocarpum +.3

172. Dzp Bzr Gmlp
Chamaedaphne calyculata, var. angustifolia 2.3 Alnus crispa, var. mollis 2.1 Myrica Gale 2.1 Kalmia angustifolia 1.2 Carex lenticularis 3.3 Carex rostrata +.3

173. Eli Dzp Hlr
Picea glauca 2.1 Picea rubens 2.1 Pinus Strobus 2.1 Vaccinium angustifolium 2.2 Comptonia peregrina 2.2 Pteridium aquilinum, var. latiusculum 1.1

174. Gml Dszp Hlp Lp
Carex stricta 3.1 Carex rostrata 1.3 Carex spp. 1.1 Calamagrostis canadensis 2.3 Eriophorum virginicum 2.1 Rhynchospora alba 1.3 Cladium mariscoides 1.3 Myrica Gale 3.1 Chamaedaphne calyculata, var. angustifolia 1.3 Alnus rugosa, var. americana 1.3 Rubus hispida, var. obovalis 2.1 Lysimachia terrestris 1.1 Drosera intermedia +.1 Pogonia ophioglossoides +.1 Sphagnum spp. 4.4

175. Dsz.mlp Bzr Hlr
Quercus rubra, var. borealis 3.1 Acer rubrum 2.1 Populus grandidentata 3.1 Betula populifolia 1.3 Comptonia peregrina 2.3 Vaccinium angustifolium 1.3 Kalmia angustifolia 1.3 Pteridium aquilinum, var. latiusculum 1.1

176. Dlsi.zp Elp Hli
Acer rubrum 3.1 Quercus rubra, var. borealis 1.1 Betula papyrifera 3.1 Populus grandidentata 2.1 Vaccinium angustifolium 3.3 Comptonia peregrina 2.3 Picea rubens 2.1 Pinus Strobus 1.1 Pteridium aquilinum, var. latiusculum 4.3 Aralia hispida +.1

177. Dzi.sp.mr Hmlp Glp Emlr
Betula populifolia 2.1 Betula papyrifera 2.1 Acer saccharum +.1 Fagus grandifolia +.1 Betula lutea +.1 Acer rubrum 2.1 Rubus idaeus, var. strigosus 1.2 Solidago canadensis 2.1 Solidago graminifolia +.1 Polygonum cilinode 1.4 Dennstaedtia punctilobula +.3 Aralia hispida +.3 Agrostis tenuis? 1.2 Danthonia spicata 2.2 Festuca capillata +.2 Picea rubens +.1 Abies balsamea +.1

178. Dsz Bszp Lp
Chamaedaphne calyculata, var. angustifolia 3.1 Myrica Gale 3.1 Ledum groenlandicum 1.1 Ilex verticillata 2.1 Viburnum cassinoides 2.1 Vaccinium corymbosum +.1 Kalmia angustifolia +.1 Rhododendron canadense +.1 Sphagnum sp. 3.3 Polytrichum sp. +.2

179. Em.lp Dszp.lr Hlp Lp
Picea rubens 3.1 Pinus resinosa 3.1 Pinus Strobus 2.1 Abies balsamea 2.1 Viburnum cassinoides 2.1 Gaylussacia baccata 1.2 Vaccinium angustifolium 3.3 Acer rubrum +.1 Gaultheria procumbens +.2 Aralia nudicaulis 1.1 Cornus canadensis 3.1 Maianthemum canadense +.1 Pteridium aquilinum, var. latiusculum 1.1 moss spp. 2.2

180. Dls Elr Hmi Glr
Fraxinus americana 4.1 Acer rubrum 2.1 Alnus rugosa, var. americana 2.3 Betula lutea +.1 Acer saccharum 1.1 Ilex verticillata 1.1 Thuja occidentalis 1.1 Pinus Strobus +.1 Osmunda regalis, var. spectabilis 3.4 Aster umbellatus 1.1 Solidago canadensis +.1 Carex spp. 1.2

181. Eml.zp
Picea rubens 5.1 Pinus Strobus 1.1

182. Eml Hl Dlsp.mzr
Picea rubens 4.1 Pinus Strobus 2.1 Abies balsamea 1.1 Pinus resinosa 1.1 Acer rubrum 2.1 Betula papyrifera +.1 Viburnum cassinoides 1.1 Gaultheria procumbens +.1 Vaccinium angustifolium 1.3 Aralia nudicaulis 1.1 Pteridium aquilinum, var. latiusculum 3.3 Maianthemum canadense 2.3 Mitchella repens +.1

183. Emlp Dlszp Hmlp Glp
Pinus Strobus 2.1 Pinus resinosa +.1 Picea rubens +.1 Picea glauca +.1 Acer rubrum 1.1 Betula papyrifera 2.1 Betula populifolia 1.1 Populus tremuloides +.1 Populus grandidentata +.1 Ilex verticillata 1.1 Viburnum cassinoides 1.1 Alnus crispa, var. mollis 1.1 Salix discolor +.1 Acer pensylvanicum +.1 Comptonia peregrina 2.2 Vaccinium angustifolium 2.3 Aralia hispida 1.1 Pteridium aquilinum, var. latiusculum 2.3 Aster macrophyllus 2.1 Solidago spp. 1.1 Danthonia spicata 2.4 Festuca capillata 1.3 Anthoxanthum odoratum 1.3 Agrostis tenuis? 1.3

184. Dszi Elsp Glp Hlr L
Populus tremuloides 2.1 Betula papyrifera 2.1 Salix discolor 1.1 Comptonia peregrina 1.3 Betula populifolia 2.1 Picea rubens 1.1 Danthonia spicata 1.3 Aralia hispida +.1 Polytrichum sp. 5.5

185. Dmsi.zp Emr Hlp
Quercus rubra, var. borealis 4.1 Betula papyrifera 2.1 Populus grandidentata 1.1 Comptonia peregrina 1.2 Vaccinium angustifolium 1.3 Pinus Strobus 1.1 Danthonia spicata +.2 Pteridium equilinum, var. latiusculum 3.1

186. Ds.zp Hlp Glp Lp
Betula populifolia 2.1 Betula papyrifera 1.1 Quercus rubra, var. borealis 1.1 Fagus grandifolia 1.1 Acer rubrum 3.1 Prunus pensylvanica 1.1 Comptonia peregrina 1.2 Populus grandidentata 1.1 Rubus allegheniensis +.1 Rubus idaeus, var. strigosus 1.4 Aralia hispida +.3 Pteridium aquilinum, var. latiusculum 1.1 Solidago canadensis +.1 Festuca capillata 1.4 Danthonia spicata +.4 Deschampsia flexuosa +.2 Carex pensylvanica? +.2 Polytrichum sp. 2.4

187. Em
Picea rubens 5.1 Picea glauca +.1

188. Dmlz
Quercus rubra, var. borealis 5.1 Acer rubrum 1.1 Betula papyrifera 1.1 Rubus allegheniensis 3.3 Rubus idaeus, var. strigosus 4.3

189. Dls Elp Hmlp
Betula populifolia 3.1 Fraxinus americana 1.1 Alnus rugosa, var. americana 3.1 Thuja occidentalis 2.1 Aster umbellatus 2.1 Dryopteris Thelypteris, var. pubescens 1.3

190. Gmlp Dsp Hmp
Calamagrostis canadensis 3.3 Scirpus cyperinus, var. pelius +.2 Salix discolor 1.1 Alnus rugosa, var. americana 3.2 Solidago canadensis 1.1

191. Dmzp Elp Hmlp Glp
Betula papyrifera 2.1 Betula populifolia 1.1 Acer rubrum 3.1 Quercus rubra, var. borealis 1.1 Fraxinus americana +.1 Comptonia peregrina +.2 Picea rubens 1.1 Pinus Strobus 1.1 Tsuga canadensis +.1 Dryopteris noveboracensis +.3 Pteridium aquilinum, var. latiusculum +.3 Osmunda Claytoniana +.2 Solidago canadensis +.2 Aster umbellatus 1.1 Aster macrophyllus +.3 Solidago rugosa +.2 Festuca capillata 2.2 Danthonia spicata 1.2 Agrostis alba? 1.2 Calamagrostis canadensis +.2 Carex spp. 2.3 Scirpus cyperinus, var. pelius 1.2

192. Dz.mlsr Elr Hlp Glp Lp
Betula papyrifera 3.1 Betula populifolia +.1 Comptonia peregrina 2.2 Populus tremuloides +.1 Prunus pensylvanica 1.1 Salix discolor +.1 Quercus rubra, var. borealis +.1 Acer rubrum 1.1 Pinus Strobus +.1 Epilobium angustifolium 1.3 Anaphalis margaritacea, var. intercedens +.2 Erigeron canadensis +.3 Agrostis scabra +.2 Agrostis alba? or tenuis? +.2 Polytrichum sp. 2.2

193. Emlp Nmlp L Dszp Bzp Hmp Glp
Picea mariana 3.1 Thuja occidentalis 1.1 Abies balsamea +.1 Larix laricina 1.1 Sphagnum sp. 5.5 Gaylussacia baccata +.1 Nemopanthus mucronata 1.1 Viburnum cassinoides 1.1 Alnus rugosa, var. americana +.1 Acer rubrum +.1 Ledum groenlandicum +.1 Rhododendron canadense +.1 Galmia angustifolia +.1 Osmunda cinnamomea +.3 Aster radula +.1 Smilacina trifolia +.1 Carex trisperma 2.4

194. Eml Nmlp Dlr Hml L
Picea mariana 2.1 Pinus Strobus 2.1 Thuja occidentalis 4.1 Larix laricina 3.1 Acer rubrum 1.1 Dryopteris noveboracensis 1.3 Osmunda regalis, var. spectabilis 2.4 Osmunda cinnamomea 3.4 Impatiens capensis 1.2 Trientalis borealis 1.1 Aster radula 1.1 Sphagnum sp. 5.5

195. Dzi Bzp Glmp Elp Nlr Hlp L wr
Myrica Gale 2.3 Gaylussacia baccata 1.3 Gaylussacia dumosa, var. Bigeloviana 2.1 Andromeda glaucophylla +.1 Pyrus melanocarpa +.1 Vaccinium Oxycoccos 1.1 Empetrum nigrum +.4 Chamaedaphne calyculata, var. angustifolia 1.4 Ledum groenlandicum +.4 Rhynchospora alba 2.4 Sarracenia purpurea +.1 Drosera rotundifolia +.3 Drosera intermedia +.3 Calopogon pulchellus +.1 Solidago uliginosa, var. linoides +.1 Aster nemoralis +.1 Calamagrostis canadensis 1.4 Eriophorum virginicum +.1 Eriophorum spissum +.1 Carex stricta 1.4 Carex lenticularis 1.4 Carex rostrata +.3 Scirpus cespitosus, var. callosus +.4 Sphagnum spp. 5.5 Picea mariana 1.1 Larix laricina 1.1 Nymphaea odorata +.5 Nuphar variegatum +.3

196. Dm.sp Elp
Betula papyrifera 3.1 Acer rubrum 3.1 Acer saccharum 1.1 Populus tremuloides 1.1 Betula lutea 1.1 Fraxinus americana 1.1 Acer pensylvanicum 2.1 Abies balsamea 3.1 Picea rubens 2.1

197. Eli Dlszp Hlp Lp
Picea rubens 2.1 Thuja occidentalis 2.1 Abies balsamea 2.1 Acer rubrum 2.1 Betula papyrifera 1.1 Vaccinium angustifolium 3.3 Viburnum cassinoides +.3 Cornus canadensis 2.3 Cladonia spp. 1.3

198. Dlp Elp Hlp Lp
Acer rubrum 3.1 Betula papyrifera 2.1 Betula populifolia 1.1 Thuja occidentalis 3.1 Abies balsamea +.1 Picea rubens +.1 Cornus canadensis 1.3 Maianthemum canadense +.3 Aralia nudicaulis +.1 Trientalis borealis +.1 moss spp. 3.4

199. Dzp Glp
Spiraea latifolia 3.1 Diervilla Lonicera 3.1 Betula populifolia 1.1 Prunus pensylvanica +.1 Alnus crispa, var. mollis +.1 Solidago Randii +.3 Festuca capillata 2.3 Calamagrostis canadensis 1.2 Danthonia spicata +.2

200. Elsp Dlp Hml
Picea glauca 3.1 Picea rubens 2.1 Betula papyrifera 3.1 Acer pensylvanicum 1.1 Acer rubrum +.1 Rubus allegheniensis 2.3 Aster macrophyllus 4.5 Aster umbellatus 1.1 Pteridium aquilinum, var. latiusculum 2.3 Aralia nudicaulis 1.1

201. w Gmlp
Nuphar variegatum 3.1 Nymphaea odorata 3.1 Sparganium chlorocarpum 1.4 Typha latifolia 2.5

202. Dsi Hmp
Alnus rugosa, var. americana 2.1 Salix gracilis 1.1 Salix discolor 1.1 Prunus pensylvanica 2.1 Betula populifolia 2.1 Betula papyrifera 2.1 Spiraea latifolia 1.1 Solidago canadensis 1.1

203. Dzi.sp.mlr Bzr Glp Hlp
Quercus rubra, var. borealis 1.1 Betula populifolia 1.1 Vaccinium angustifolium 4.4 Comptonia peregrina 4.3 Spiraea latifolia 1.2 Kalmia angustifolia 1.3 Viburnum cassinoides +.1 Danthonia spicata 3.3 Festuca capillata 1.3 Pteridium aquilinum, var. latiusculum 1.3 Aster macrophyllus +.1 Aster umbellatus +.1 Hieracium aurantiacum +.1 Hieracium pratense +.1 Apocynum androsaemifolium +.1

204. Gm Dzp.sr wr
Carex stricta? 5.4 Calamagrostis canadensis +.2 Myrica Gale 2.3 Spiraea latifolia +.1 Alnus rugosa, var. americana +.3 Acer rubrum +.3 Chamaedaphne calyculata, var. angustifolia +.2 Nuphar variegatum +.2

205. Gl Hlp Dlr
Poa pratensis 5.5 Agrostis tenuis 1.1 Festuca capillata +.2 Trifolium repens 1.3 Ranunculus acris +.2 Ranunculus bulbosus +.1 Cerastium vulgatum +.2 Rumex acetosella +.2

206. Emp Nmp Dzp.lr Lp Hlr Gmr
Picea mariana 3.1 Larix laricina 3.1 Abies balsamea +.1 Betula populifolia +.2 Comptonia peregrina 2.3 Vaccinium angustifolium 3.3 Myrica Gale 3.2 Viburnum cassinoides +.1 Chamaedaphne calyculata, var. angustifolia +.1 Ledum groenlandicum +.2 Sphagnum spp. 1.3 Osmunda regalis, var. spectabilis +.2 Osmunda cinnamomea +.2 Calamagrostis canadensis +.3

207. Dzi.sr Hlp Glp
Comptonia peregrina 4.3 Vaccinium angustifolium 4.4 Betula populifolia +.1 Aster umbellatus +.1 Pteridium aquilinum, var. latiusculum +.3 Oryzopsis asperifolia +.2 Danthonia spicata 2.2

208. Emi Nmi Dsp Gmp Hmp L
Picea mariana 3.1 Larix laricina 3.1 Alnus rugosa, var. americana 3.3 Acer rubrum +.1 Viburnum cassinoides +.1 Carex trisperma 3.3 Calamagrostis canadensis 2.3 Rubus pubescens +.1 Cornus canadensis 1.3 Lysimachia terrestris 1.1 Smilacina trifolia 1.1 Coptis groenlandica +.3 Dryopteris Thelypteris, var. pubescens +.1 Osmunda cinnamomea +.1 Sphagnum sp. or spp. 5.4

209. Dsz Elr Hlp
Comptonia peregrina 4.3 Betula populifolia 2.1 Vaccinium angustifolium 1.3 Pinus Strobus 1.1 Pteridium aquilinum, var. latiusculum 2.2 Aralia hispida 1.1

210. Dszi Gmp Lp
Acer rubrum 1.1 Alnus rugosa, var. americana 2.2 Spiraea latifolia 3.4 Vaccinium macrocarpon +.3 Typha latifolia 2.4 Carex spp. 1.3 Carex rostrata, var. utriculata 1.2 Calamagrostis canadensis +.2 Sphagnum sp. or spp. 4.4

211. Dsi.zp.mlr Emlr Hmp Glp
Quercus rubra, var. borealis 3.1 Acer rubrum 3.1 Betula populifolia 1.1 Comptonia peregrina 1.4 Vaccinium angustifolium 2.4 Pinus Strobus 1.1 Pteridium aquilinum, var. latiusculum 2.4 Danthonia spicata 1.2

212. Dzi.sp Hmp
Quercus rubra, var. borealis 1.1 Acer rubrum +.1 Betula populifolia 1.2 Comptonia peregrina 3.4 Vaccinium angustifolium 3.4 Pteridium aquilinum, var. latiusculum 2.2

213. Dli.szp Glp Hlp
Betula populifolia 3.1 Betula papyrifera 1.1 Quercus rubra, var. borealis 2.1 Acer rubrum 2.1 Comptonia peregrina 2.4 Danthonia spicata +.2 Festuca capillata +.2 Poa pratensis +.2 Pteridium aquilinum, var. latiusculum 2.4 Aster umbellatus +.1 Lysimachia quadrifolia +.3

214. Gm Dszp Lp
Calamagrostis canadensis 5.5 Carex spp. +.2 Typha latifolia +.2 Alnus rugosa, var. americana +.3 Chamaedaphne calyculata, var. angustifolia +.1 Myrica Gale 1.3 Ledum groenlandicum +.2 Sphagnum sp. or spp. 1.1

215. Dsz Glr L
Chamaedaphne calyculata, var. angustifolia 5.5 Myrica Gale +.3 Carex spp. +.4 Sphagnum spp. 5.5

216. Emlp Dzp Bzp L
Picea mariana 3.1 Vaccinium angustifolium 1.1 Chamaedaphne calyculata, var. angustifolia 1.2 Rhododendron canadense 3.1 Kalmia angustifolia 3.1 Ledum groenlandicum 1.1 Cladonia spp. 4.3

217. Dz.sr Glp Hlp
Comptonia peregrina 3.4 Spiraea latifolia 2.3 Alnus rugosa, var. americana 2.3 Danthonia spicata 1.1 Festuca capillata 3.2 Agrostis tenuis 1.2 Ranunculus acris +.1 Chrysanthemum Leucanthemum, var. pinnatifidum +.2 Ranunculus bulbosus +.1

218. El Dsp Nlr
Picea mariana 4.1 Acer rubrum +.1 Alnus rugosa, var. americana 3.4 Larix laricina 1.1

219. Dsz Hmp Glp
Acer rubrum 2.1 Quercus rubra, var. borealis 1.1 Comptonia peregrina 3.3 Betula populifolia 1.3 Populus grandidentata +.1 Gaylussacia baccata +.3 Rubus idaeus, var. strigosus +.2 Rubus allegheniensis +.2 Pteridium aquilinum, var. latiusculum 2.1 Festuca capillata 1.2 Danthonia spicata 1.2

220. Dml.zp Elr Hmp
Quercus rubra, var. borealis 5.1 Betula populifolia 2.1 Populus grandidentata +.1 Vaccinium angustifolium +.3 Picea rubens +.1 Pinus Strobus +.1 Abies balsamea +.1 Pteridium aquilinum, var. latiusculum 2.1

221. Not on map.

222. Eml Dzp.lsr Nmlp Hmlp Lp
Picea mariana 5.1 Abies balsamea +.1 Acer rubrum +.1 Alnus rugosa, var. americana +.3 Vaccinium angustifolium 1.3 Larix laricina 1.1 Pteridium aquilinum, var. latiusculum 1.3 Cornus canadensis 1.2 Osmunda cinnamomea +.1 Osmunda Claytoniana +.1 Equisetum sylvaticum, forma multiramosum +.1 Calamagrostis canadensis +.3 moss spp. 1.3 Sphagnum sp. or spp. +.3

223. Eml Dszp Hmlp Glmp L
Picea mariana 5.1 Alnus rugosa, var. americana +.1 Acer rubrum +.1 Viburnum cassinoides +.1 Ilex verticillata +.1 Nemopanthus mucronata +.1 Ledum groenlandicum +.1 Gaultheria hispidula +.1 Osmunda regalis, var. spectabilis +.1 Osmunda cinnamomea 1.1 Carex trisperma 4.5 Calamagrostis canadensis +.4 Carex paupercula, var. irrigua +.1 Sphagnum sp. or spp. 5.5

224. Eml Nmlp Dlszp Hmlp Glmp L
Picea mariana 5.1 Larix laricina 1.1 Acer rubrum 1.1 Ledum groenlandicum +.3 Osmunda cinnamomea 3.3 Trientalis borealis +.1 Carex trisperma 4.5 Calamagrostis canadensis +.3 Sphagnum sp. or spp. 5.5

225. Not on map.

226. Gml Dzp Hlp
Festuca rubra 4.5 Agrostis tenuis 4.5 Agropyron repens 1.3 Danthonia spicata +.1 Phleum pratense +.1 Comptonia peregrina 1.3 Hieracium pratense +.1 Hieracium floribundum +.1 Hieracium Pilosella +.1 Hieracium aurantiacum +.1 Vicia Cracca +.3

227. Eml Dlp Hlp Lp
Abies balsamea 4.1 Picea glauca 2.1 Picea rubens +.1 Betula populifolia 1.1 Betula papyrifera +.1 Trientalis borealis +.1 Maianthemum canadense 1.1 Cornus canadensis 1.1 Linnaea borealis, var. americana +.1 Pteridium aquilinum, var. latiusculum +.1 moss spp. 2.3 Acer rubrum 2.1

228. Dli.zp Elp Hlp
Quercus rubra, var. borealis 2.1 Acer rubrum 1.1 Betula populifolia 3.1 Vaccinium angustifolium 2.4 Comptonia peregrina 1.3 Pinus Strobus 2.1 Abies balsamea 2.1 Picea rubens 1.1 Pteridium aquilinum, var. latiusculum 1.1

229. Not on map.

230. Not on map.

231. Gml Hmlp
Dactylis glomerata 2.3 Anthoxanthum odoratum 4.3 Festuca rubra 1.2 Rhinanthus Crista-galli 2.1 Chrysanthemum Leucanthemum, var. pinnatifidum 1.2 Stellaria graminea 1.1 Ranunculus acris +.2 Vicia Cracca 1.3 Hieracium pratense 1.3 Hieracium aurantiacum +.2

232. Dzp Bzp Hlp Glp Lp bp
Vaccinium angustifolium 2.3 Pyrus melanocarpa 3.3 Alnus crispa, var. mollis 1.1 Kalmia angustifolia 2.3 Potentilla tridentata +.1 Arenaria groenlandica +.3 Solidago Randii +.1 Hypericum gentianoides +.2 Deschampsia flexuosa 2.3 Cladonia spp. 2.3

233. Dmls Elr Hml Glp Lp
Acer rubrum 4.1 Fraxinus nigra 1.1 Alnus rugosa, var. americana +.3 Ilex verticillata +.1 Abies balsamea 1.1 Thuja occidentalis +.1 Onoclea sensibilis 2.1 Aster umbellatus 1.1 Osmunda Claytoniana +.2 Osmunda cinnamomea +.2 Rubus pubescens +.1 Athyrium Filix-femina, var. Michauxii? +.2 Arisaema strorubens +.1 Equisetum sylvaticum, forma multiramosum 1.3 Calamagrostis canadensis 3.3 Carex spp. 1.2 Sphagnum sp. or spp. 2.3.

234. Gl Hlp
Festuca rubra 3.2 Anthoxanthum odoratum 2.2 Agrostis tenuis 3.2 Agropyron repens 1.1 Phleum pratense 1.1 Carex spp., incl. especially Carex scoparia, 1.4 Scirpus spp. +.2 Chrysanthemum Leucanthemum, var. pinnatifidum 1.2 Vicia Cracca 2.3 Rhinanthus Crista-galli 1.1 Hieracium pratense +.2 Hieracium aurantiacum +.2 Ranunculus acris +.1 Stellaria graminea +.1 Rumex Acetosella +.2 Luzula multiflora +.1

235. Ds.zp Emlr Hlp Lp
Quercus rubra, var. borealis 3.1 Acer rubrum 3.1 Populus grandidentata 1.1 Populus tremuloides +.1 Betula papyrifera +.1 Comptonia peregrina 2.1 Vaccinium angustifolium 1.2 Diervilla Lonicera 2.4 Pinus Strobus 1.1 Pinus resinosa 1.1 Pteridium aquilinum, var. latiusculum 1.1 Polytrichum sp. 2.2

236. Eli.zp Dli
Picea rubens 3.1 Thuja occidentalis 1.1 Juniperus communis, var. depressa 1.3 Acer rubrum 2.1 Betula populifolia 1.1 Pinus rigida +.1 Polypodium virginianum +.2

237. Dzp Bzr Eszr Hlp Glr Lp bp
Vaccinium angustifolium 2.4 Betula populifolia 1.3 Pyrus melanocarpa +.1 Kalmia angustifolia 1.3 Pinus rigida 1.1 Juniperus communis, var. depressa +.2 Potentilla tridentata 1.3 Hypericum gentianoides +.3 Arenaria groenlandica +.2 Deschampsia flexuosa +.2 lichen spp. 4.4

238. Dli.sp.zr Eli Hmlp Glr Lp
Betula populifolia 4.1 Alnus rugosa, var. americana 1.1 Vaccinium angustifolium +.3 Picea rubens 3.1 Thuja occidentalis 3.1 Picea glauca 1.1 Abies balsamea 1.1 Aster umbellatus 1.2 Dryopteris noveboracensis 1.3 Viola cucullata +.2 Festuca capillata 1.3 moss spp. 2.3

239. Gl Dzr Hlr
Festuca capillata 4.2 Agrostis tenuis 3.2 Danthonia spicata 1.2 Vaccinium angustifolium +.3 Vaccinium Vitis-Idaea, var. minus +.3 Hieracium pratense +.1 Ranunculus acris +.1 Solidago nemoralis +.1

240. Gml Hml
Dactylis glomerata 2.2 Phleum pratense 2.2 Festuca rubra 2.2 Agrostis tenuis (possibly also A. alba) 2.2 Anthoxanthum odoratum +.2 Agro-

pyron repens +.2 Rumex Acetosella 3.1 Chrysanthemum Leucanthemum, var. pinnatifidum 2.3 Ambrosia artemisiifolia, var. elatior 1.1 Hieracium pratense 1.1 Hieracium floribundum 1.1 Trifolium agrarium 1.2 Trifolium pratense +.2 Trifolium repens +.2 Trifolium hybridum +.1 Raphanus Raphanistrum +.1 Vicia Cracca +.1 Vicia tetrasperma +.1 Stellaria graminea +.1 Triticum spp. +.1

241. Gml Hmlp Dszp Esr
Festuca rubra 3.2 Festuca capillata 2.2 Danthonia spicata 2.2 Agrostis tenuis 2.2 Agropyron repens 1.2 Luzula multiflora +.2 Chrysanthemum Leucanthemum, var. pinnatifidum +.2 Solidago canadensis +.3 Solidago graminifolia +.1 Solidago nemoralis +.1 Vicia Cracca +.1 Potentilla simplex, var. calvescens +.1 Comptonia peregrina 2.3 Alnus rugosa, var. americana 1.4 Pinus Strobus 1.1

242. Gl Dsp Elr Hmlp
Festuca capillata 3.2 Festuca rubra 2.3 Agrostis tenuis, possibly also A. alba, 2.3 Agropyron repens 1.3 Phleum pratense +.2 Anthoxanthum odoratum 2.2 Typha latifolia 1.4 Carex spp., especially C. scoparia, +.2 Luzula multiflora +.2 Comptonia peregrina 1.4 Alnus rugosa, var. americana 2.4 Spiraea latifolia +.1 Betula populifolia +.1 Rosa carolina? +.1 Pinus rigida 1.1 Potentilla simplex, var. calvescens 1.1 Solidago graminifolia 1.1 Ranunculus acris 1.1 Rhinanthus Crista-galli 1.1 Vicia Cracca +.1 Chrysanthemum Leucanthemum, var. pinnatifidum +.1 Aster umbellatus +.1

243. Gm Dsp
Calamagrostis canadensis 5.5 Populus tremuloides 3.3 Acer rubrum +.1 Salix discolor and probably S. gracilis +.1

244. Ds.lp
Populus tremuloides 4.1 Spiraea latifolia 2.1 Salix discolor and probably S. gracilis 2.1 Betula populifolia 2.1

245. Gm Dlsp
Calamagrostis canadensis 5.5 Spiraea latifolia 1.1 Salix discolor and probably S. gracilis 1.1 Populus tremuloides 1.1 Betula populifolia +.1

246. Dls Glr
Populus tremuloides 5.1 Spiraea latifolia 3.1 Comptonia peregrina 1.4 Betula populifolia +.1 Rosa palustris? (possibly R. carolina) +.1 Agrostis tenuis, possibly also A. alba, +.2

247. Dzp Bzp
Kalmia angustifolia 3.1 Ledum groenlandicum 2.1 Chamaedaphne calyculata, var. angustifolia 3.1 Rhododendron canadense 3.1

248. Emi Dlsp Hmlp Glp
Pinus resinosa 3.1 Pinus Strobus 1.1 Quercus rubra, var. borealis 2.1 Acer rubrum 3.1 Betula papyrifera 1.1 Populus grandidentata +.1 Fagus grandifolia +.1 Acer pensylvanicum +.1 Hamamelis virginiana +.1 Comptonia peregrina +.3 Pteridium aquilinum, var. latiusculum +.3 Osmunda Claytoniana +.3 Lysimachia quadrifolia +.3 Maianthemum canadense +.3 Aster macrophyllus +.1 Hieracium pratense +.1 Solidago bicolor +.1 Poa compressa 1.3 Festuca capillata 1.3

249. Ds.mzp Emr Hlp Lp
Acer rubrum 3.1 Quercus rubra, var. borealis 2.1 Betula papyrifera 4.1 Prunus pensylvanica +.1 Comptonia peregrina 2.3 Vaccinium angustifolium 1.3 Pinus Strobus 1.1 Tsuga canadensis 1.1 Pteridium aquilinum, var. latiusculum 1.1 Aralia hispida +.1 Gaultheria procumbens +.1 Polytrichum sp. 1.2

250. Dz.sp Bzp Hlp Glr Ezr Lp bp
Betula populifolia 3.1 Vaccinium angustifolium 3.3 Prunus pensylvanica +.1 Diervilla Lonicera +.2 Pyrus melanocarpa +.2 Kalmia angustifolia 2.3 Pteridium aquilinum, var. latiusculum 1.1 Potentilla tridentata 1.3 Danthonia spicata +.2 Deschampsia flexuosa +.2 Pinus rigida +.1 lichen spp. 2.4 Polytrichum sp. 1.3

251. Dsz.mp Emr Hlp
Acer rubrum 3.1 Quercus rubra, var. borealis 2.1 Betula papyrifera 3.1 Populus grandidentata 2.1 Populus tremuloides +.1 Fraxinus americana +.1 Acer pensylvanicum +.1 Comptonia peregrina 3.3 Alnus rugosa, var. americana +.4 Pinus Strobus 1.1 Pteridium aquilinum, var. latiusculum 2.1 Aster macrophyllus 2.3 Lysimachia quadrifolia 1.1 Osmunda Claytoniana +.3 Dryopteris noveboracensis +.2

252. Dszp Elr Glp bp
Betula papyrifera 4.1 Comptonia peregrina 3.1 Quercus rubra, var. borealis 2.1 Acer rubrum +.1 Fraxinus americana +.1 Prunus pensylvanica +.1 Vaccinium angustifolium 1.2 Pinus rigida 1.1 Deschampsia flexuosa 1.2 Danthonia spicata 1.2 Aralia hispida +.1

253. Dszi Gmlp Hmlr
Quercus rubra, var. borealis 3.1 Acer rubrum 1.1 Betula papyrifera 3.1 Prunus pensylvanica 1.1 Populus tremuloides +.1 Diervilla Lonicera 1.1 Comptonia peregrina 1.3 Spiraea latifolia 1.1 Rubus idaeus, var. strigosus 1.1 Alnus crispa, var. mollis +.4 Salix discolor +.1 Rhus typhina +.1 Danthonia spicata 2.2 Deschampsia flexuosa 1.2 Festuca capillata +.4 Calamagrostis canadensis +.3 Aralia hispida +.1 Aster macrophyllus +.1

254. Gl Hlp
Festuca rubra 5.5 Festuca capillata 2.3 Agropyron repens 2.2 Anthoxanthum odoratum 1.2 Agrostis tenuis 1.2 Phleum pratense 1.2 Poa compressa 1.2 Dactylis glomerata 1.2 Vicia Cracca 1.1 Hypericum perforatum +.3 Chrysanthemum Leucanthemum, var. pinnatifidum +.3 Cirsium arvense +.3 Hieracium pratense +.3 Rosa carolina? +.3 Picea glauca +.1 Alnus rugosa, var. americana 3.3 Betula papyrifera 2.1 Populus tremuloides 2.3 Prunus pensylvanica 2.3 Rubus allegheniensis 1.3 Spiraea latifolia 1.1 Osmunda Claytoniana 1.3

255. Dszi Gmlp Hmp
Salix discolor 3.1 Salix gracilis? 3.1 Salix rigida +.1 Spiraea latifolia 3.1 Typha latifolia 1.3 Typha angustifolia +.3 Scirpus cyperinus, var. pelius +.3 Agrostis tenuis, perhaps also A. alba, 2.3 Carex scoparia 2.2 Calamagrostis canadensis +.2 Lythrum Salicarea 2.3 Aster novi-belgii 1.1 Lysimachia terrestris +.3

256. Ds.mlzp Emr Hmlp Glp
Betula papyrifera 3.1 Populus tremuloides 2.1 Prunus pensylvanica 2.1 Fraxinus americana +.1 Acer pensylvanicum +.1 Acer spicatum +.1 Acer rubrum +.1 Rubus allegheniensis 2.2 Comptonia peregrina 1.2 Abies balsamea +.1 Picea rubens +.1 Aster macrophyllus 1.3 Pteridium aquilinum, var. latiusculum +.1 Danthonia spicata 1.2

257. Dz.sp Hmlp Glp Elr
Betula populifolia 2.1 Betula papyrifera 2.1 Populus tremuloides 1.1 Vaccinium angustifolium 3.3 Rubus idaeus, var. strigosus 1.2 Salix discolor 1.1 Pteridium aquilinum, var. latiusculum 1.3 Aralia hispida 1.1 Maianthemum canadense 1.4 Cornus canadensis 1.4 Festuca capillata 2.2 Deschampsia flexuosa 1.2 Picea glauca +.1 Picea rubens 1.1 Abies balsamea 1.1

258. Dsz Elr Glp Lp
Quercus rubra, var. borealis 2.1 Prunus pensylvanica 2.1 Betula papyrifera 2.1 Betula populifolia 1.1 Diervilla Lonicera 2.3 Spiraea latifolia 1.1 Vaccinium angustifolium 1.3 Pinus Strobus 1.1 Deschampsia flexuosa 2.2 moss spp. 3.3

259. Dzp Hlp Glp Lp Ezr bp
Vaccinium angustifolium 2.3 Pyrus melanocarpa 1.2 Betula papyrifera +.1 Betula populifolia +.1 Prunus pensylvanica +.1 Gaylussacia baccata +.2 Deschampsia flexuosa 2.2 Danthonia spicata 1.2 Potentilla tridentata 2.3 Solidago Randii +.1 Arenaria groenlandica +.2 Aralia hispida +.1 Hypericum gentianoides +.3 Polytrichum sp. 1.2 lichen spp. 2.3 Pinus rigida +.1 Kalmia angustifolia +.2

260. Dm.sp Hml Gmp Emlr Lp
Betula lutea 3.1 Fraxinus americana 2.1 Acer rubrum 3.1 Acer saccharum +.1 Acer pensylvanicum 1.1 Tsuga canadensis +.1 Picea rubens +.1 Abies balsamea +.1 Thuja occidentalis +.1 Osmunda cinnamomea 1.2 Dryopteris noveboracensis 3.4 Viola pallens 1.1 Athyrium Filix-femina, var. Michauxii? +.2 Osmunda Claytoniana 1.3 Aster umbellatus +.1 Onoclea sensibilis +.2 Dryopteris disjuncta +.2 Aster acuminatus 1.1 Aralia nudicaulis + .1 Calamagrostis canadensis + .3 Carex crinita 2.2 Brachyelytrum erectum, var. septentrionale 1.2 Carex lurida +.1 Sphagnum sp. 2.3 Mnium sp. 1.2 moss spp. 1.3

261. Ds.mlp Hmp Gmlr
Populus grandidentata 3.1 Betula papyrifera 3.1 Acer rubrum 2.1 Acer saccharum 1.1 Fraxinus americana 1.1 Fagus grandifolia 1.1 Betula lutea 1.1 Rubus idaeus, var. strigosus 2.1 Rubus allegheniensis 4.1 Solidago canadensis 1.1 Solidago rugosa 1.1 Solidago graminifolia 1.1 Aster lateriflorus 1.1 Aster macrophyllus 1.3 Lysimachia quadrifolia 1.4 Carex gracillima 1.2 Carex crinita 1.3

262. Dms Hmp Gmlr
Populus grandidentata 3.1 Betula papyrifera 3.1 Acer rubrum 2.1 Acer saccharum 1.1 Fraxinus americana 1.1 Fagus grandifolia 1.1 Betula lutea 1.1 Quercus rubra, var. borealis +.1 Rubus allegheniensis 4.1 Rubus idaeus, var. strigosus 2.1 Solidago canadensis 1.1 Solidago rugosa 1.1 Solidago graminifolia 1.1 Aster lateriflorus 1.1 Aster macro-

phyllus 1.3 Lysimachia quadrifolia 1.4 Carex gracillima 1.2 Carex crinita 1.3

263. Dsz.lp Emr Hmlp Glp
Betula papyrifera 2.1 Betula populifolia 2.1 Populus grandidentata 3.1 Acer rubrum 3.1 Vaccinium angustifolium 3.4 Comptonia peregrina 2.3 Pinus Strobus 1.1 Aster macrophyllus 1.2 Pteridium aquilinum, var. latiusculum 2.1 Pinus resinosa 1.1 Poa compressa +.2 Deschampsia flexuosa 1.2 Danthonia spicata 1.2

264. Gml Hmlp Dszp
Festuca capillata 4.5 Agropyron repens 2.4 Agrostis tenuis 2.2 Poa pratensis 1.2 Festuca rubra 1.2 Phleum pratense +.2 Aster novi-belgii 1.1 Potentilla tridentata +.3 Rhinanthus Crista-galli 1.1 Rosa carolina? 3.1 Pteridium aquilinum, var. latiusculum +.3 Vaccinium angustifolium 2.3 Spiraea latifolia 2.1 Alnus crispa, var. mollis 1.1 Populus alba 1.3 Prunus pensylvanica 1.3 Rhus typhina +.3

265. Gml Hml Dsr
Festuca rubra 3.2 Dactylis glomerata 3.2 Poa pratensis 2.2 Phleum pratense 2.2 Agropyron repens 2.2 Agrostis tenuis 2.2 Aster umbellatus 2.1 Vicia Cracca 2.1 Stellaria graminea 1.1 Hieracium aurantiacum 1.1 Hieracium pratense 1.1 Aster novi-belgii 1.1 Solidago juncea +.1 Solidago rugosa +.1 Ranunculus acris +.1 Hemerocallis fulva +.3 Rubus idaeus, var. strigosus 2.2 Spiraea latifolia +.3

266. Ds Emr Gmlp Hmlp
Alnus crispa, var. mollis 3.1 Alnus rugosa, var. americana 2.1 Spiraea latifolia 2.1 Rosa carolina? 2.1 Amelanchier laevis 1.1 Betula papyrifera 1.1 Betula populifolia +.1 Populus tremuloides 1.1 Picea glauca +.1 Agropyron repens, Phleum pratense, Poa pratensis, Festuca rubra, Agrostis tenuis, Vicia Cracca, Aster umbellatus, Hieracium pratense, Chrysanthemum Leucanthemum, var. pinnatifidum, Stellaria graminea, Hieracium aurantiacum

267. Dls Emlr Hmlp Glr
Betula papyrifera 3.1 Betula populifolia 3.1 Populus tremuloides 1.1 Spiraea latifolia 4.1 Amelanchier laevis +.1 Picea glauca 1.1 Aster umbellatus 3.1 Aralia nudicaulis 1.1 Aster macrophyllus +.2 Maianthemum canadense +.1 Calamagrostis canadensis 1.3

268. Not on map.

269. Emli.szp Dlp Hlp Lp
Picea rubens 4.1 Thuja occidentalis 3.1 Pinus Strobus 1.1 Abies balsamea +.1 Juniperus communis, var. depressa +.1 Acer rubrum 1.1 Populus grandidentata +.1 Betula papyrifera +.1 Betula populifolia 1.1 Vaccinium angustifolium 2.2 Gaylussacia baccata 2.2 Gaultheria procumbens +.1 Clintonia borealis +.1 Maianthemum canadense +.1 Cornus canadensis +.1 Aster umbellatus +.1 Aster macrophyllus +.3 Aster acuminatus +.1 Trientalis borealis +.1 Pteridium aquilinum, var. latiusculum +.3 Solidago squarrosa? +.1 moss spp. 2.3 Cladonia and other lichen spp. 1.2 Agrostis scabra +.1

270. Dz.slp Hlp Lp
Betula populifolia 5.1 Acer rubrum 2.1 Populus tremuloides 1.1 Amelanchier laevis +.1 Pteridium aquilinum, var. latiusculum 1.2 Solidago rugosa +.1 Polytrichum sp. 2.3

271. Dsi.lzp Glp
Betula papyrifera 3.1 Betula populifolia 2.1 Acer pensylvanicum 1.1 Populus grandidentata +.1 Prunus pensylvanica +.1 Diervilla Lonicera 1.3 Vaccinium angustifolium 1.3 Danthonia spicata 1.2 Deschampsia flexuosa 1.2

272. Dml Emlp Hmlp
Acer rubrum 4.1 Populus grandidentata 2.1 Betula papyrifera 1.1 Acer pensylvanicum 2.1 Picea rubens 2.1 Abies balsamea 2.1 Thuja occidentalis 2.1 Maianthemum canadense +.4 Clintonia borealis +.1 Aster macrophyllus +.1 Pteridium aquilinum, var. latiusculum +.1 Aster umbellatus 1.1 Solidago graminifolia 1.1 Solidago rugosa +.1 Dryopteris Phegopteris +.1 Osmunda cinnamomea +.1 Osmunda Claytoniana +.1 Equisetum sylvaticum, forma multiramosum +.3

273. Eml Dlsp Hmlp L
Thuja occidentalis 5.1 Acer rubrum 1.1 Ilex verticillata 2.1 Nemopanthus mucronata 2.1 Alnus rugosa, var. americana +.1 Fraxinus americana +.1 Osmunda cinnamomea 2.1 Osmunda regalis, var. spectabilis 1.3 Sphagnum spp. 5.5

274. El Dlsp Hml Lp
Thuja occidentalis 4.1 Picea rubens 1.1 Abies balsamea 1.1 Acer rubrum 3.1 Betula lutea +.1 Betula papyrifera +.1 Ilex verticillata 2.1 Nemopanthus mucronata 1.1 Osmunda cinnamomea 2.1 Osmunda Claytoniana 2.1 Dryopteris noveboracensis 4.5 Sphagnum spp. 3.3

275. Dl Hml Glr
Acer rubrum 4.1 Betula papyrifera 3.1 Populus tremuloides 1.1 Fraxinus americana +.1 Acer pensylvanicum +.1 Aster macrophyllus 4.4 Aster umbellatus 1.1 Lysimachia quadrifolia +.1 Dryopteris noveboracensis 1.3 Osmunda Claytoniana +.3 Pteridium aquilinum, var. latiusculum +.1 Poa compressa +.1

276. Dls.mzp Hml Glr
Populus grandidentata 3.1 Betula papyrifera 2.1 Populus tremuloides 2.1 Betula populifolia 2.1 Fraxinus americana 1.1 Acer rubrum 1.1 Comptonia peregrina 2.3 Diervilla Lonicera 1.3 Pteridium aquilinum, var. latiusculum 3.3 Aster macrophyllus 3.3 Lysimachia quadrifolia 1.3 Festuca capillata 1.3

277. Dsz Hmlp Lp Gmr
Betula populifolia 4.1 Betula papyrifera 2.1 Populus grandidentata 1.1 Populus tremuloides 1.1 Acer rubrum 1.1 Comptonia peregrina 2.2 Rubus idaeus, var. strigosus 2.3 Rubus allegheniensis 1.3 Salix discolor +.1 Pteridium aquilinum, var. latiusculum 2.1 Aster acuminatus 1.1 Aster umbellatus +.1 Aralia hispida +.1 Polytrichum spp. 2.3 Scirpus cyperinus, var. pelius +.1

278. Dms Elr Hmlp Lp
Fraxinus americana 2.1 Acer rubrum 2.1 Acer pensylvanicum 2.1 Populus grandidentata 2.1 Acer saccharum 1.1 Fagus grandifolia 1.1

Betula lutea 1.1 Sambucus pubens +.1 Tsuga canadensis 1.1 Thuja occidentalis 1.1 Brachyelytrum erectum, var. septentrionale +.1 Rubus idaeus, var. strigosus 3.4 Rubus allegheniensis 1.1 Lysimachia quadrifolia 1.1 Aster acuminatus 1.1 Aster macrophyllus 1.3 Osmunda Claytoniana 1.3 Viola pallens 1.1 Athyrium thelypteroides +.1 moss spp. 2.2

279. Dsz Hmlp
Betula papyrifera 3.1 Betula populifolia 3.1 Populus tremuloides 2.1 Populus grandidentata 2.1 Acer rubrum 1.1 Comptonia peregrina 3.2 Pteridium aquilinum, var. latiusculum 2.1 Aster macrophyllus 2.3 Aralia hispida +.1 Solidago rugosa 1.1 Solidago squarrosa +.1

280. Dli.zp Elp Hmlp Lp
Betula papyrifera 4.1 Fraxinus americana +.1 Populus tremuloides 1.1 Populus grandidentata 1.1 Acer rubrum 1.1 Acer pensylvanicum 1.1 Comptonia peregrina 2.1 Diervilla Lonicera 1.1 Rubus idaeus, var. strigosus 1.2 Rubus allegheniensis +.1 Thuja occidentalis 2.1 Pinus resinosa +.1 Pinus Strobus +.1 Picea rubens 1.1 Aster umbellatus 1.1 Aralia hispida 1.1 Polytrichum sp. 2.2

281. Eml Dzp.sr Glr
Pinus rigida 3.1 Pinus Strobus 1.1 Thuja occidentalis +.1 Betula papyrifera 1.1 Betula populifolia 1.1 Populus grandidentata 1.1 Acer pensylvanicum 1.1 Vaccinium angustifolium 1.3 Comptonia peregrina 1.1 Spiraea latifolia 1.3 Diervilla Lonicera 1.3 Danthonia spicata 1.2 Deschampsia flexuosa 1.2

282. Dszp Lp bp
Betula papyrifera 3.1 Betula populifolia 3.1 Populus tremuloides +.1 Salix discolor +.1 Prunus pensylvanica +.1 Polytrichum sp. 2.3

283. Dls Hmlp
Acer rubrum 3.1 Betula populifolia 3.1 Alnus rugosa, var. americana 2.1 Salix discolor +.1 Betula papyrifera 2.1 Spiraea latifolia 2.1 Populus tremuloides 1.1 Amelanchier laevis +.1 Alnus crispa, var. mollis +.1 Fraxinus americana +.1 Ilex verticillata +.1 Rubus hispidus 1.1 Osmunda Claytoniana 1.1 Osmunda cinnamomea 1.1 Aster umbellatus 3.1 Aster macrophyllus 1.4 Dryopteris noveboracensis +.4 Solidago rugosa +.1

284. Gl Hlp Dzr
Festuca rubra 4.2 Agrostis tenuis 3.2 Anthoxanthum odoratum 2.2 Festuca capillata 1.2 Phleum pratense 1.2 Dactylis glomerata +.2 Carex scoparia +.2 Luzula multiflora +.2 Potentilla simplex, var. calvescens 2.1 Solidago rugosa 2.1 Solidago juncea 1.1 Solidago graminifolia 1.1 Solidago nemoralis +.1 Chrysanthemum Leucanthemum, var. pinnatifidum 1.1 Stellaria graminea 1.1 Vicia Cracca 1.1 Trifolium repens 1.1 Trifolium hybridum +.1 Trifolium pratense +.1 Aster umbellatus +.1 Hieracium floribundum +.1 Spiraea latifolia 1.1

285. Gml Hlp.mr Dsp.mr
Agrostis tenuis 3.2 Festuca rubra 2.2 Festuca capillata 2.2 Dactylis glomerata 1.2 Phleum pratense 1.2 Anthoxanthum odoratum 1.2 Poa pratensis 1.2 Carex conoidea? +.2 Potentilla simplex, var. calvescens 2.1 Solidago rugosa 2.1 Solidago graminifolia 1.1 Solidago juncea 1.1

Rhinanthus Crista-galli 1.1 Aster umbellatus 1.1 Aster novi-belgii +.1 Vicia Cracca 1.1 Stellaria graminea +.1 Chrysanthemum Leucanthemum, var. pannatifidum +.1 Hypericum perforatum +.1 Hieracium pratense +.1 Ranunculus acris +.1 Alnus crispa, var. mollis 1.1 Rosa carolina? 1.1 Spiraea latifolia +.1 Betula papyrifera +.1 Acer rubrum +.1 Fraxinus americana +.1 Pyrus malus +.1 Salix alba, var. vitellina +.1

286. Ds.lzp Hmlp Glmp
Populus tremuloides 3.1 Betula populifolia 3.1 Populus grandidentata 2.1 Betula papyrifera 2.1 Alnus rugosa, var. americana 3.1 Spiraea latifolia 2.1 Fraxinus americana +.1 Rosa carolina? 1.1 Salix discolor +.1 Rubus allegheniensis +.1 Prunus pensylvanica +.1 Aster umbellatus 2.1 Aster macrophyllus 1.3 Solidago rugosa 2.1 Solidago graminifolia +.1 Onoclea sensibilis +.1 Carex crinita +.1 Festuca rubra 2.2 Agrostis tenuis 1.2 Dactylis glomerata +.2 Agropyron repens +.2 Festuca capillata +.2 Poa pratensis +.2 Chrysanthemum Leucanthemum, var. pinnatifidum +.1 Vicia Cracca 1.1 Comptonia peregrina 2.1

287. Dmli Emlr Hmlp Gmlr
Acer rubrum 3.1 Betula papyrifera 2.1 Alnus rugosa, var. americana 2.1 Fraxinus americana +.1 Populus tremuloides +.1 Picea rubens +.1 Pinus Strobus +.1 Abies balsamea +.1 Diervilla Lonicera +.3 Dryopteris noveboracensis 2.3 Pteridium aquilinum, var. latiusculum 2.1 Aster macrophyllus 2.4 Aster umbellatus 2.1 Aster acuminatus +.3 Osmunda Claytoniana 1.2 Solidago rugosa +.1 Solidago graminifolia 1.1 Hieracium pratense +.2 Hieracium floribundum +.2 Lysimachia quadrifolia +.3 Carex crinita 1.2 Scirpus cyperinus, var. pelius +.2 Agrostis tenuis +.2

288. Dsz.lp.mr Hmlp Glp Lp
Betula populifolia 4.1 Populus tremuloides 3.1 Betula papyrifera 2.1 Prunus pensylvanica 1.1 Fraxinus americana +.1 Comptonia peregrina 2.1 Diervilla Lonicera +.1 Aralia hispida 1.1 Pteridium aquilinum, var. latiusculum 1.1 Hieracium pratense 1.1 Hieracium floribundum 1.1 Solidago juncea +.1 Danthonia spicata 1.2 Carex pensylvanica? 1.2 Agrostis scabra +.2 Polytrichum sp. 3.2

289. Gml Hmlp Dsp.lr
Festuca capillata 2.3 Poa pratensis 2.2 Agrostis tenuis 2.2 Agropyron repens 1.2 Phleum pratense +.1 Solidago rugosa 2.1 Apocynum androsaemifolium 1.5 Vicia Cracca 1.1 Pteridium aquilinum, var. latiusculum 1.4 Lupinus polyphyllus +.1 Solidago juncea +.1 Aster novi-belgii +.1 Rubus hispidus 2.1 Spiraea latifolia 2.1 Rosa carolina? 2.1 Celastrus scandens +.4 Betula populifolia +.1 Alnus crispa, var. mollis +.1 Acer rubrum +.1 Fraxinus americana +.1

290. Ds.mlp Hmlp
Acer rubrum 3.1 Spiraea latifolia 3.1 Betula papyrifera 2.1 Betula populifolia 2.1 Populus grandidentata +.1 Populus tremuloides 1.1 Alnus crispa, var. mollis 1.1 Salix discolor +.1 Alnus rugosa, var. americana 2.1 Comptonia peregrina 1.3 Ilex verticillata +.1 Rosa carolina? +.1 Aster umbellatus 3.1 Pteridium aquilinum, var. latiusculum 1.3 Solidago rugosa 1.1 Agrostis tenuis +.2

291. Dlsi Elr Hml Glp
Populus grandidentata 3.1 Populus tremuloides 1.1 Acer rubrum 2.1 Fraxinus americana +.1 Betula papyrifera 1.1 Betula populifolia 1.1 Comptonia peregrina 2.1 Diervilla Lonicera 1.2 Picea rubens 1.1 Aster macrophyllus 3.4 Pteridium aquilinum, var. latiusculum 2.3 Danthonia spicata 2.2 Polytrichum sp. 1.3

292. Dlsi Elp.mr Hmlp
Acer rubrum 3.1 Alnus crispa, var. mollis 1.3 Betula papyrifera 3.1 Betula populifolia 2.1 Fraxinus americana 2.1 Acer spicatum 2.1 Betula lutea +.1 Thuja occidentalis 3.1 Abies balsamea 2.1 Picea rubens 1.1 Tsuga canadensis +.1 Aster macrophyllus 2.3 Aster acuminatus +.1 Solidago rugosa 1.1 Clintonia borealis +.1 Thalictrum polygamum +.3 Onoclea sensibilis +.3 Dryopteris spinulosa +.1 Athyrium Filix-femina, var. Michauxii? +.1

293. Dsz.mlp Emlp Hmlp Glr Lp
Betula populifolia 3.1 Betula papyrifera 2.1 Acer rubrum 2.1 Fraxinus americana 2.1 Populus tremuloides 2.1 Sambucus pubens +.1 Salix discolor +.1 Rubus allegheniensis 1.2 Rubus idaeus, var. strigosus 1.2 Prunus pensylvanica +.1 Diervilla Lonicera 2.3 Picea rubens 2.1 Pinus Strobus +.1 Thuja occidentalis +.1 Aster macrophyllus 1.3 Hieracium floribundum 1.2 Agrostis tenuis +.2 Festuca capillata +.2 moss spp. 3.3

294. Emli Dli.szr Hlp Lp
Picea rubens 3.1 Abies balsamea 2.1 Thuja occidentalis 1.1 Pinus Strobus 1.1 Betula papyrifera 3.1 Acer rubrum 2.1 Acer pensylvanicum +.1 Populus grandidentata +.1 Nemopanthus mucronata +.1 Viburnum cassinoides +.1 Vaccinium angustifolium 1.3 Aster macrophyllus 1.3 Aralia nudicaulis +.1 Maianthemum canadense 1.1 Pteridium aquilinum, var. latiusculum 1.1 lichen spp. 2.3

295. Gml Hlp Lr
Poa pratensis 3.4 Festuca rubra 3.5 Agropyron repens 2.2 Festuca capillata 2.2 Danthonia spicata 1.2 Phleum pratense +.2 Agrostis tenuis 1.2 Hypericum perforatum 2.1 Stellaria graminea +.4 Thymus Serpyllum +.3 Hieracium Pilosella +.3 Rumex Acetosella +.1 Lechea intermedia, var. juniperina +.1 Potentilla simplex, var. calvescens +.1 moss spp. +.2

296. Gml Hlp
Poa pratensis Festuca rubra Agrostis tenuis Phleum pratense Agropyron repens Rumex Acetosella Hieracium pratense etc.

297. Gml Hmlp Lp
Festuca rubra Festuca capillata Phleum pratense Agropyron repens Danthonia spicata Agrostis tenuis Luzula multiflora Hieracium spp. Rhinanthus Crista-galli Rumex Acetosella Chrysanthemum Leucanthemum, var. pinnatifidum Polytrichum spp.

298. Gml Hmlp
Agrostis tenuis 4.2 Anthoxanthum odoratum 3.2 Poa pratensis 2.2 Luzula multiflora 2.2 Phleum pratense 1.2 Festuca rubra 1.3 Dactylis glomerata +.1 Carex scoparia +.1 Carex conoidea? +.1 Festuca

capillata +.2 Panicum sp. +.1 Hieracium spp. 1.3 Stellaria graminea 1.1 Hieracium Pilosella +.1 Solidago canadensis +.1 Solidago juncea +.1 Solidago rugosa +.1 Solidago graminifolia +.1 Ranunculus acris 1.2 Achillea Millefolium +.2 Potentilla simplex, var. calvescens +.1

299. Dz.sr Hmlp Glp L bp
Betula papyrifera 3.1 Betula populifolia 3.1 Prunus pensylvanica 1.1 Salix discolor 1.1 Alnus crispa, var. mollis +.1 Acer rubrum +.1 Populus tremuloides +.1 Diervilla Lonicera 2.1 Spiraea latifolia +.1 Aster umbellatus 2.1 Aralia hispida 1.1 Solidago Randii 1.1 Deschampsia flexuosa 2.2 Polytrichum sp. 4.3

300. El Dlszp Hlp Gmp
Thuja occidentalis 3.1 Picea rubens 2.1 Abies balsamea +.1 Betula papyrifera 3.1 Betula populifolia 2.1 Acer pensylvanicum +.1 Acer rubrum +.1 Spiraea latifolia 1.1 Viburnum cassinoides +.1 Acer spicatum +.1 Vaccinium angustifolium 2.3 Pyrus melanocarpa +.1 Aster umbellatus 2.1 Polypodium virginianum +.1 Calamagrostis canadensis 1.3

301. Dl.sr Gm Hm
Acer rubrum 5.1 Betula papyrifera 2.1 Betula lutea +.1 Acer pensylvanicum 1.1 Rubus pubescens 1.4 Calamagrostis canadensis 5.5 Brachyelytrum erectum, var. septentrionale 1.3 Aster umbellatus 3.1 Aster acuminatus 2.1 Glyceria canadensis 2.3 Dryopteris noveboracensis 2.3 Osmunda Claytoniana 2.1

302. Dl.szp Elr Hlm Gmp Lp
Acer rubrum 4.1 Betula papyrifera 3.1 Betula lutea 1.1 Acer pensylvanicum 2.1 Populus tremuloides 2.1 Alnus crispa, var. mollis 1.1 Vaccinium angustifolium 1.3 Abies balsamea 1.1 Aster umbellatus 3.1 Pteridium aquilinum, var. latiusculum 3.3 Cornus canadensis 2.3 Dryopteris noveboracensis 1.3 Coptis groenlandica +.1 Aster acuminatus +.1 Osmunda Claytoniana +.3 Calamagrostis canadensis 2.3 Brachyelytrum erectum, var. septentrionale +.3 Polytrichum sp. 1.3

303. Dsz Elp Glp Bzr bp Hlr
Betula populifolia 5.5 Vaccinium angustifolium 2.4 Gaylussacia baccata 1.3 Nemopanthus mucronata +.1 Pyrus melanocarpa 1.1 Picea rubens 3.1 Danthonia spicata 2.2 Pinus Banksiana 1.1 Kalmia angustifolia 1.2 Pteridium aquilinum, var. latiusculum 1.1

304. Dlzi.sp Elp Bzp Lp Glr Hlr
Betula papyrifera 4.1 Vaccinium angustifolium 3.3 Viburnum cassinoides +.1 Pyrus americana +.1 Pyrus melanocarpa +.1 Abies balsamea 3.1 Picea rubens 1.1 Kalmia angustifolia 3.3 lichen spp. 2.3 Potentilla tridentata 1.2 Danthonia spicata 1.2 Deschampsia flexuosa 1.2

305. Glp Elr Dszp Hlp Bzr bp
Danthonia spicata 3.4 Deschampsia flexuosa 1.4 Festuca capillata 2.4 Agropyron repens 1.3 Agrostis scabra 1.2 Agrostis tenuis 1.2 Festuca rubra +.2 Abies balsamea 1.1 Picea rubens +.1 Thuja occidentalis +.1 Betula populifolia 2.1 Vaccinium angustifolium 2.3 Pyrus melanocarpa 2.2 Spiraea latifolia 2.1 Pyrus americana 2.1 Alnus crispa, var. mollis 2.1 Prunus pensylvanica 1.1 Potentilla tridentata 1.2 Chrysan-

themum Leucanthemum, var. pinnatifidum 2.2 Ambrosia artemisiifolia, var. elatior 2.1 Potentilla simplex, var. calvescens +.4 Solidago Randii +.1 Arenaria groenlandica +.2 Achillea Millefolium +.2 Hypericum perforatum +.1 Kalmia angustifolia 2.3

306. Dszi Elp Glp bp
Betula populifolia 3.1 Vaccinium angustifolium 3.3 Pyrus melanocarpa 2.1 Spiraea latifolia 1.1 Kalmia angustifolia +.1 Picea rubens 3.1 Thuja occidentalis 2.1 Abies balsamea 1.1 Danthonia spicata 2.2 Deschampsia flexuosa 1.2 Potentilla tridentata +.1 Cladonia spp. +.2

307. Eli Ds.zp Glp Lp bp Hmlr
Thuja occidentalis 3.1 Picea rubens 1.1 Betula populifolia 4.1 Betula papyrifera +.1 Pyrus americana +.1 Vaccinium angustifolium 2.4 Viburnum cassinoides +.1 Pyrus melanocarpa +.1 Deschampsia flexuosa 2.2 Danthonia spicata 2.2 Calamagrostis canadensis +.3 Aster umbellatus 2.1 Potentilla tridentata 1.2 Polytrichum sp. 2.2 Acer rubrum +.1

308. Gl Dszp Lp
Deschampsia flexuosa 3.3 Danthonia spicata 3.3 Betula populifolia 3.1 Spiraea latifolia 2.1 Pyrus melanocarpa 1.2 Diervilla Lonicera 1.1 Vaccinium angustifolium 2.4 Potentilla tridentata +.2 Cladonia spp. 2.2 Polytrichum sp. 2.2 Prunus pensylvanica +.1

309. Dmli.zp Emlr Hmp Glp
Quercus rubra, var. borealis 3.1 Acer rubrum 2.1 Betula papyrifera 3.1 Spiraea latifolia 1.2 Comptonia peregrina 2.4 Vaccinium angustifolium 2.4 Pinus Strobus 1.1 Picea glauca +.1 Pteridium aquilinum, var. latiusculum 2.3 Aster umbellatus 1.1 Solidago spp. 1.1 Agrostis tenuis? 3.2

310. Em.lp Dmlsp
Pinus Strobus 4.1 Picea rubens 1.1 Quercus rubra, var. borealis 3.1 Fagus grandifolia +.1 Corylus cornuta +.1

311. Dsz.lp Hlp Glr
Betula populifolia 4.1 Populus grandidentata 2.1 Acer rubrum 2.1 Quercus rubra, var. borealis +.1 Comptonia peregrina 3.3 Vaccinium angustifolium 3.3 Acer pensylvanicum +.1 Pteridium aquilinum, var. latiusculum 3.4 Danthonia spicata 1.2

312. Dli.zp Elp Hlp
Betula papyrifera 2.1 Betula populifolia 2.1 Acer rubrum 2.1 Quercus rubra, var. borealis +.1 Vaccinium angustifolium 1.3 Comptonia peregrina +.2 Pinus Strobus 2.1 Picea rubens +.1 Pteridium aquilinum, var. latiusculum 1.2 Aster umbellatus 1.3 Abies balsamea 1.1

313. Em.lp Dlp Hlp
Pinus Strobus 4.1 Picea rubens 3.1 Abies balsamea 3.1 Acer rubrum 1.1 Betula populifolia 1.1 Aster umbellatus 1.1

314. Dml Elp Hmlp Glr
Quercus rubra, var. borealis 3.1 Acer rubrum 3.1 Fraxinus americana 1.1 Betula papyrifera 1.1 Betula populifolia 1.1 Betula lutea +.1 Picea rubens 2.1 Pinus Strobus 1.1 Osmunda cinnamomea 2.2 Dryopteris spp. 1.1 Aster umbellatus 1.1 Carex crinita +.3

315. Dm.lsi Elr
Quercus rubra, var. borealis 4.1 Acer rubrum 3.1 Acer pensylvanicum 2.1 Fagus grandifolia 1.1 Picea rubens 1.1

316. Dli.mszp Emlp Hml Glp
Acer rubrum 4.1 Quercus rubra, var. borealis 1.1 Vaccinium angustifolium 2.3 Picea rubens 2.1 Picea glauca 2.1 Pinus Strobus 2.1 Pinus resinosa 1.1 Maianthemum canadense 3.4 Pteridium aquilinum, var. latisculum 2.1 Aster umbellatus 3.1 Dryopteris noveboracensis 1.4 Osmunda cinnamomea 1.1 Carex spp. 1.3 Equisetum sylvaticum, forma multiramosum +.3 Abies balsamea 1.1

317. Dls.zp Elr Hlp Glp
Betula populifolia 4.1 Betula papyrifera 2.1 Populus grandidentata 2.1 Acer rubrum 1.1 Fraxinus americana +.1 Gaylussacia baccata 2.3 Spiraea latifolia 1.1 Pinus Strobus +.1 Picea rubens +.1 Picea glauca +.1 Thuja occidentalis +.1 Comptonia peregrina 1.3 Aralia hispida 1.1 Pteridium aquilinum, var. latiusculum +.3 Aster macrophyllus +.2 Danthonia spicata 1.2

318. Em.lp Dlzp
Picea rubens 4.1 Pinus Strobus 3.1 Pinus resinosa 2.1 Thuja occidentalis 3.1 Betula papyrifera 1.1 Acer rubrum 1.1 Acer pensylvanicum +.1 Populus grandidentata +.1 Gaylussacia baccata +.3

319. El.mp Dlp L
Picea rubens 5.1 Thuja occidentalis 2.1 Acer rubrum 1.1 Betula papyrifera 1.1 moss and lichen spp. 4.4

320. Eli Nlp Dzp.sr Glp Lp
Thuja occidentalis 4.1 Larix laricina 2.1 Acer rubrum 1.1 Alnus crispa, var. mollis +.1 Rhododendron canadense 1.1 Ilex verticillata +.1 Osmunda regalis, var. spectabilis +.2 Scirpus cyperinus, var. pelius 2.3 Carex spp. 2.3 Calamagrostis canadensis +.2 Sphagnum sp. 2.5

321. Dl.sp Elp Hmp
Betula papyrifera 4.1 Acer rubrum 3.1 Betula populifolia 1.1 Comptonia peregrina +.4 Alnus crispa, var. mollis 2.1 Pinus Strobus 2.1 Abies balsamea 2.1 Aster umbellatus 2.4 Populus grandidentata +.1

322. Dml Elp.mr Hlp
Acer rubrum 3.1 Betula papyrifera 3.1 Betula lutea +.1 Acer pensylvanicum +.1 Abies balsamea 3.1 Picea rubens 2.1 Pinus Strobus 1.1 Maianthemum canadense 1.4 Aralia nudicaulis +.1

323. Dl Elp Hm
Betula papyrifera 4.1 Acer rubrum 3.1 Betula populifolia 1.1 Viburnum cassinoides +.1 Betula lutea +.1 Abies balsamea 3.1 Picea rubens 1.1 Pinus Strobus +.1 Aster umbellatus 4.4 Osmunda Claytoniana +.3 Equisetum sylvaticum, forma multiramosum +.4

324. Dms Emlp
Betula papyrifera 3.1 Acer rubrum 3.1 Fagus grandifolia 1.1 Betula populifolia +.1 Acer saccharum +.1 Fraxinus americana +.1 Acer pensylvanicum 3.1 Picea rubens 3.1 Tsuga canadensis 1.1

325. Dls Emlp
Acer rubrum 3.1 Betula papyrifera 3.1 Betula populifolia 2.1 Acer pensylvanicum 1.1 Picea rubens 2.1 Pinus Strobus 2.1 Pinus resinosa 1.1

326. Dl Elp bp
Acer pensylvanicum 3.1 Betula papyrifera 3.1 Acer rubrum 3.1 Picea rubens 3.1

327. Elp Nlp Dlsp Gm Hmp L
Thuja occidentalis 4.1 Larix laricina 3.1 Acer rubrum 2.1 Alnus rugosa, var. americana 2.1 Ilex verticillata 2.1 Calamagrostis canadensis 5.5 Osmunda cinnamomea 2.2 Sphagnum sp. 5.5

328. Esi Gmp Hmlp Dmsr
Abies balsamea 3.1 Picea rubens 3.1 Pinus Strobus 1.1 Carex scoparia 1.2 Carex lurida 1.4 Carex crinita 1.2 Carex sp. 1.2 Scirpus cyperinus, var. pelius 1.2 Danthonia spicata +.2 Aster umbellatus 2.1 Dryopteris noveboracensis 2.4 Cornus canadensis 2.4 Rubus hispidus 1.4 Acer rubrum 1.1

329. Dls.zp Elp.mr Glp
Betula papyrifera 4.1 Acer rubrum 3.1 Betula populifolia 1.1 Populus grandidentata 1.1 Viburnum cassinoides 1.1 Acer pensylvanicum 1.1 Vaccinium angustifolium 2.4 Abies balsamea 2.1 Picea rubens 2.1 Danthonia spicata 1.2 Deschampsia flexuosa +.2

330. Dl.sp
Acer rubrum 4.1 Betula papyrifera 3.1 Fraxinus americana 2.1 Betula populifolia 1.1 Acer pensylvanicum 1.1

331. Dlszp Elp Glp Hmlp Lp
Betula populifolia 4.1 Acer rubrum 3.1 Betula papyrifera 2.1 Acer pensylvanicum 1.1 Vaccinium angustifolium 2.4 Gaylussacia baccata +.3 Viburnum cassinoides +.1 Picea rubens 2.1 Pinus Strobus +.1 Pinus resinosa +.1 Thuja occidentalis 1.1 Abies balsamea +.1 Danthonia spicata 2.3 Deschampsia flexuosa 1.3 Pteridium aquilinum, var. latiusculum 1.1 Aster umbellatus 1.1 Potentilla tridentata +.3 Hypericum gentianoides +.3 lichen spp. 1.3

332. Dml Emlp
Acer rubrum 4.1 Quercus rubra, var. borealis 2.1 Betula populifolia 2.1 Populus grandidentata 1.1 Fraxinus americana 1.1 Acer saccharum 1.1 Acer pensylvanicum +.1 Picea rubens 2.1 Thuja occidentalis 2.1

333. Dlszp Elp Hlr Bzp Glp Lp
Betula populifolia 3.1 Acer rubrum 3.1 Betula papyrifera 2.1 Viburnum cassinoides 1.1 Gaylussacia baccata 1.4 Pyrus melanocarpa 1.4 Acer pensylvanicum +.1 Prunus pensylvanica +.1 Vaccinium angustifolium 2.4 Picea rubens 3.1 Thuja occidentalis 1.1 Abies balsamea +.1 Pteridium aquilinum, var. latiusculum 1.3 Kalmia angustifolia 2.4 Deschampsia flexuosa 2.2 Danthonia spicata 2.2 lichen spp. 2.3

334. Eli Nmp Hmp L Dlr
Thuja occidentalis 4.1 Larix laricina 2.1 Picea mariana 2.1 Picea rubens +.1 Pinus Strobus +.1 Dryopteris noveboracensis +.3 Os-

munda regalis, var. spectabilis +.3 Osmunda cinnamomea 1.4 Sphagnum sp. or spp. 4.5 Acer rubrum +.1

335. Dmli.sp Gl Hmlp
Acer rubrum 3.1 Quercus rubra, var. borealis 3.1 Betula papyrifera 2.1 Acer pensylvanicum 2.1 Festuca rubra 4.3 Poa compressa 2.2 Danthonia spicata 2.2 Lysimachia quadrifolia +.3 Anaphalis margaritacea, var. intercedens 2.3 Pteridium aquilinum, var. latiusculum 1.3 Aster umbellatus 2.1

336. Dml.sp Glm Elr Hmr
Acer rubrum 4.1 Betula papyrifera 3.1 Acer pensylvanicum 2.1 Brachyelytrum erectum, var. septentrionale 5.5 Picea rubens 1.1 Aster umbellatus 1.1

337. Eml Dlzp Glp
Picea rubens 5.1 Acer rubrum 2.1 Betula papyrifera 2.1 Acer pensylvanicum +.1 Vaccinium angustifolium 3.3 Viburnum cassinoides +.1 Deschampsia flexuosa 1.2 Danthonia spicata 1.2

338. Eml Dz.lp Lp Hlr
Picea rubens 4.1 Thuja occidentalis 1.1 Pinus resinosa +.1 Betula papyrifera 3.1 Acer rubrum 2.1 Vaccinium angustifolium 4.4 Populus grandidentata +.1 Gaylussacia baccata +.3 lichen spp. 1.3 Pteridium aquilinum, var. latiusculum +.3

339. Dmli.szp Glp Hlp
Quercus rubra, var. borealis 4.1 Acer rubrum 2.1 Betula papyrifera 2.1 Fagus grandifolia +.1 Acer pensylvanicum 2.1 Comptonia peregrina 2.3 Rubus idaeus, var. strigosus 1.3 Danthonia spicata 3.2 Pteridium aquilinum, var. latiusculum 2.3

340. Eli Dlp
Thuja occidentalis 4.1 Acer rubrum 3.1 Betula papyrifera 2.1

341. Dsz.lp Hmp
Acer rubrum 3.1 Quercus rubra, var. borealis 1.1 Betula populifolia 3.1 Betula papyrifera 2.1 Prunus pensylvanica 1.1 Comptonia peregrina 2.2 Rubus idaeus, var. strigosus 1.1 Solidago rugosa +.1 Solidago graminifolia +.1 Solidago canadensis +.1 Aster umbellatus 1.1 Pteridium aquilinum, var. latiusculum 1.3

342. Dz Hlp Glp
Vaccinium angustifolium 4.3 Comptonia peregrina 3.3 Betula populifolia 3.1 Pteridium aquilinum, var. latiusculum 2.1 Danthonia spicata 1.2

343. Dz.lr Elp Hmlp Lp
Betula populifolia 3.1 Comptonia peregrina 3.3 Pinus Strobus 1.1 Pinus resinosa +.1 Pteridium aquilinum, var. latiusculum 2.3 Polytrichum sp. 3.3

344. Eml Nlp Ds.lr Gm Hmr L
Thuja occidentalis 4.1 Picea mariana 3.1 Larix laricina 3.1 Ilex verticillata 3.1 Viburnum cassinoides 2.1 Amelanchier laevis 2.1 Alnus crispa, var. mollis 1.1 Acer rubrum 1.1 Betula papyrifera +.1 Calamagrostis canadensis 5.5 Osmunda cinnamomea +.1 Sphagnum sp. 5.5

345. Dmli.szp Emlp Hmp Lp
Quercus rubra, var. borealis 3.1 Acer rubrum 2.1 Betula populifolia 2.1 Betula papyrifera 1.1 Populus grandidentata +.1 Comptonia peregrina 1.2 Vaccinium angustifolium 2.3 Pinus Strobus 3.1 Abies balsamea 2.1 Picea rubens 1.1 Pteridium aquilinum, var. latiusculum 2.3 moss spp. 3.3

346. Gl Dlzp Elp
Festuca capillata 3.3 Agrostis tenuis 3.3 Festuca rubra 3.3 Betula papyrifera 2.1 Betula populifolia 1.1 Acer rubrum +.1 Spiraea latifolia 1.1 Gaylussacia baccata +.2 Comptonia peregrina 2.2 Vaccinium angustifolium 3.3 Pinus Strobus 2.1

347. Dsz Hmp Bzp
Populus grandidentata 4.1 Betula populifolia 4.1 Quercus rubra, var. borealis 3.1 Acer rubrum 1.1 Vaccinium angustifolium 3.3 Comptonia peregrina 2.2 Gaylussacia baccata +.1 Pteridium aquilinum, var. latiusculum 4.1 Kalmia angustifolia 1.1

348. Dmsz Hmp
Quercus rubra, var. borealis 5.1 Acer rubrum 3.1 Betula populifolia 2.1 Betula papyrifera 1.1 Populus grandidentata +.1 Gaylussacia baccata 1.3 Comptonia peregrina 1.2 Vaccinium angustifolium 2.3 Pteridium aquilinum, var. latisculum 3.1 Kalmia angustifolia +.1

349. El Ds.lp Hmp Gmlp L
Thuja occidentalis 4.1 Abies balsamea 2.1 Acer rubrum 2.1 Alnus crispa, var. mollis 2.1 Ilex verticillata 2.1 Viburnum cassinoides 2.1 Osmunda cinnamomea 4.1 Calamagrostis canadensis 3.3 Carex spp. 2.3 Sphagnum sp. 4.3

350. Dszi.lr Glp Hlp
Quercus rubra, var. borealis 1.1 Vaccinium angustifolium 3.3 Comptonia peregrina 3.2 Betula populifolia 4.1 Danthonia spicata 2.2 Agrostis tenuis 1.2 Poa sp. 1.2 Pteridium aquilinum, var. latiusculum 2.2

351. Dlzi.sp.mr Hmp Glr
Quercus rubra, var. borealis 3.1 Acer rubrum 2.1 Betula populifolia 3.1 Betula papyrifera 2.1 Fraxinus americana +.1 Acer pensylvanicum 1.1 Comptonia peregrina 2.3 Rubus idaeus, var. strigosus 1.1 Aster umbellatus +.3 Pteridium aquilinum, var. latiusculum 2.3 Agrostis tenuis? +.2 Danthonia spicata +.2

352. Dsz.mr Hmp
Betula populifolia 3.1 Betula papyrifera 2.1 Comptonia peregrina 3.1 Populus grandidentata 1.1 Quercus rubra, var. borealis 1.1 Acer rubrum +.1 Rubus idaeus, var. strigosus 1.3 Aralia hispida 1.2 Pteridium aquilinum, var. latisculum 2.2

353. Eml Dlp Lp
Abies balsamea 4.1 Picea rubens 2.1 Pinus Strobus +.1 Betula papyrifera 2.1 moss spp. 2.2

354. Dmi.lsp Gmp Hmlp Elr
Acer rubrum 4.1 Quercus rubra, var. borealis 1.1 Fraxinus americana 1.1 Acer pensylvanicum 1.1 Rubus idaeus, var. strigosus +.3 Betula papyrifera +.1 Calamagrostis canadensis 2.4 Carex gracillima 2.4

Carex crinita 2.4 Equisetum sylvaticum, forma multiramosum +.3 Aster umbellatus 2.1 Osmunda cinnamomea +.2 Dryopteris noveboracensis 1.3 Picea rubens +.1

355. Ds
Betula populifolia 4.1 Fagus grandifolia 2.1 Acer rubrum 1.1 Acer pensylvanicum +.1 Aralia hispida +.1 Rubus idaeus, var. strigosis +.1

356. Elp.mr Nmlp Dmlp
Thuja occidentalis 3.1 Picea rubens 2.1 Pinus Strobus 1.1 Larix laricina 3.1 Acer rubrum 2.1 Fraxinus americana 2.1 Betula papyrifera 1.1

357. Dl El
Acer rubrum 2.1 Quercus rubra, var. borealis 2.1 Betula populifolia 3.1 Populus grandidentata 1.1 Picea rubens 5.1 Abies balsamea 1.1

358. Dl.sp Elp
Acer rubrum 3.1 Alnus rugosa, var. americana 2.1 Betula papyrifera 2.1 Betula populifolia 2.1 Prunus pensylvanica 1.1 Picea glauca 2.1 Pinus Strobus 2.1

359. Eml Dl
Picea rubens 3.1 Picea glauca 2.1 Pinus Strobus 2.1 Tsuga canadensis +.1 Acer rubrum 3.1 Acer pensylvanicum 1.1 Betula papyrifera 2.1 Betula populifolia 1.1 Quercus rubra, var. borealis +.1

360. El Dlr Hmp Glp Lp
Thuja occidentalis 5.1 Picea rubens +.1 Pinus Strobus +.1 Fraxinus americana +.1 Osmunda cinnamomea 3.3 Carex spp. 2.2 Sphagnum sp. 3.3 moss spp. 3.3

361. Dzi.sp Hmlp
Betula populifolia 4.1 Comptonia peregrina 3.2 Vaccinium angustifolium 2.3 Acer rubrum 1.1 Populus grandidentata 1.1 Aralia hispida +.1 Pteridium aquilinum, var. latiusculum 2.1

362. Eli
Pinus rigida 3.1 Thuja occidentalis 2.1

363. Dlszp Elp Glp Hmlp
Betula populifolia 2.3 Betula papyrifera 1.1 Acer rubrum 1.1 Acer pensylvanicum +.1 Vaccinium angustifolium 3.3 Viburnum cassinoides +.1 Picea rubens 2.1 Deschampsia flexuosa 3.3 Calamagrostis canadensis +.3 Aster umbellatus 1.1 Pteridium aquilinum, var. latiusculum 1.1

364. Eli Dlp bp
Thuja occidentalis 4.1 Betula papyrifera 2.1 Acer rubrum 2.1 Acer saccharum 1.1 Betula populifolia 1.1

365. Elp Dlp bp
Thuja occidentalis 3.1 Picea rubens 1.1 Betula populifolia 2.1 Betula papyrifera 1.1

366. El Dlp bp
Picea rubens 4.1 Thuja occidentalis 2.1 Betula populifolia 2.1 Betula papyrifera 1.1

367. Dm.sp Emlp Hmp Gmp
Fagus grandifolia 3.1 Acer saccharum 2.1 Betula lutea 2.1 Acer rubrum 2.1 Acer pensylvanicum 2.1 Betula papyrifera 1.1 Fraxinus americana +.1 Tsuga canadensis 2.1 Picea rubens 1.1 Osmunda Claytoniana 1.3 Aster umbellatus +.1 Carex crinita +.2 Brachyelytrum erectum, var. septentrionale 1.3

368. Em Dzp Hmlp
Pinus Strobus 5.1 Betula populifolia 2.1 Vaccinium angustifolium 3.3 Comptonia peregrina 1.2 Rubus idaeus, var. strigosus 2.3 Pteridium aquilinum, var. latiusculum 1.1 Cornus canadensis 2.1

369. Dzp Bzp Hlp Glp Lp Elr bp
Pyrus melanocarpa 3.3 Vaccinium angustifolium 2.3 Alnus crispa, var. mollis 1.1 Kalmia angustifolia 1.3 Potentilla tridentata +.1 Arenaria groenlandica +.3 Solidago Randii +.1 Hypericum gentianoides +.2 Deschampsia flexuosa 2.3 Cladonia spp. 2.3 Picea rubens 1.1

370. Dl Elr Gm Hmp
Acer rubrum 5.1 Betula lutea 1.1 Acer pensylvanicum 1.1 Picea rubens 1.1 Abies balsamea 1.1 Calamagrostis canadensis 4.3 Brachyelytrum erectum, var. septentrionale 3.3 Aster umbellatus 2.1

371. Elp Dszp.lr Hlp Glp Lp bp
Picea rubens 3.1 Betula populifolia 3.1 Gaylussacia baccata 2.3 Viburnum cassinoides 1.1 Prunus pensylvanica 1.1 Vaccinium angustifolium 2.3 Acer rubrum +.1 Acer pensylvanicum +.1 Pyrus melanocarpa +.2 Aster umbellatus 1.2 Pteridium aquilinum, var. latiusculum 1.1 Deschampsia flexuosa 2.2 Danthonia spicata +.2 moss spp. 2.2 lichen spp. 2.2

372. Dml.sp Emlp.si Hlp
Acer rubrum 3.1 Betula papyrifera 3.1 Picea rubens 4.1 Abies balsamea 2.1 Pinus Strobus 1.1 Maianthemum canadense 2.1 Cornus canadensis 1.1

373. Dl.msp Elp.mr Hlp Lp
Betula papyrifera 3.1 Acer rubrum 3.1 Fagus grandifolia 1.1 Acer pensylvanicum 2.1 Betula lutea +.1 Picea rubens 3.1 Abies balsamea +.1 moss spp. 3.3 Cornus canadensis 1.1 Maianthemum canadense 1.1 Pteridium aquilinum, var. latiusculum 1.3

374. Eli Dlr.si Hmlp Glr L Nlr
Thuja occidentalis 5.1 Larix laricina +.1 Nemopanthus mucronata 2.1 Ilex verticillata 2.1 Acer rubrum 1.1 Betula papyrifera +.1 Alnus rugosa, var. americana 1.1 Osmunda regalis, var. spectabilis 2.3 Osmunda Claytoniana 1.2 Osmunda cinnamomea 1.2 Cornus canadensis 2.1 Sarracenia purpurea +.2 Gaultheria procumbens +.1 Carex spp. 1.2 Sphagnum sp. 4.4

375. Dszp Glp Hlp Elr Lp bp
Betula papyrifera 2.1 Betula populifolia 2.1 Gaylussacia baccata 2.3 Viburnum cassinoides +.1 Vaccinium angustifolium 2.3 Acer rubrum 1.1 Acer pensylvanicum 1.1 Amelanchier laevis +.1 Pyrus melano-

carpa +.2 Deschampsia flexuosa 2.3 Danthonia spicata 1.2 Hypericum gentianoides 1.3 Pteridium aquilinum, var. latiusculum 1.1 Arenaria groenlandica +.2 Potentilla tridentata +.2 Picea rubens 1.1 lichen spp. 3.3

376. Em Dlp
Picea rubens 5.1 Acer rubrum 2.1 Betula papyrifera 1.1

377. Elp Dlszp Hmp Glr Bzp Lp
Picea rubens 3.1 Abies balsamea +.1 Vaccinium Vitis-Idaea, var. minus +.3 Vaccinium angustifolium 3.3 Pteridium aquilinum, var. latiusculum 1.1 Danthonia spicata 1.2 Acer rubrum 2.1 Betula papyrifera 1.1 Ilex verticillata 1.1 Nemopanthus mucronata 2.1 Rhododendron canadense +.1 Myrica Gale 2.2 Ledum groenlandicum +.2 Kalmia angustifolia 1.2 Picea mariana +.1 Osmunda cinnamomea 1.2 Sphagnum sp. 2.3 lichen spp. 3.3

378. Elp Dlszp Glp Hmlp Lp bp
Picea rubens 1.1 Thuja occidentalis 1.1 Pinus Strobus +.1 Betula populifolia 2.1 Betula papyrifera +.1 Acer rubrum 1.1 Gaylussacia baccata 2.1 Viburnum cassinoides 1.1 Pyrus melanocarpa 2.3 Vaccinium angustifolium 2.3 Fraxinus americana 1.1 Danthonia spicata 2.2 Brachyelytrum erectum, var. septentrionale 2.3 Deschampsia flexuosa 2.2 Hypericum gentianoides 1.3 Aster umbellatus 2.4 Arenaria groenlandica +.3 Potentilla tridentata +.2 Cladonia spp. 1.3 lichen spp. 1.3

379. Emli Dmli.szp Hlp Glr Lp
Pinus Strobus 3.1 Picea rubens 3.1 Abies balsamea 1.1 Thuja occidentalis +.1 Acer rubrum 3.1 Betula papyrifera 2.1 Acer pensylvanicum 1.1 Gaylussacia baccata 2.3 Vaccinium angustifolium 2.2 Gaultheria procumbens +.2 Maianthemum canadense 2.1 Pteridium aquilinum, var. latiusculum 2.1 Danthonia spicata 1.2 lichen spp. 2.3

380. Emli Dmlzp Hlp Lp
Picea rubens 3.1 Abies balsamea 2.1 Thuja occidentalis 1.1 Acer rubrum 2.1 Betula papyrifera 2.1 Acer pensylvanicum +.1 Vaccinium angustifolium 1.3 Cornus canadensis 1.1 Pteridium aquilinum, var. latisculum 2.3 Maianthemum canadense 1.1 moss & lichen spp. 4.3

381. Em Dlzp Hlp Lp
Picea rubens 5.1 Pinus Strobus 1.1 Abies balsamea 1.1 Thuja occidentalis +.1 Betula papyrifera 2.1 Acer rubrum 2.1 Acer pensylvanicum 1.1 Vaccinium angustifolium 1.3 Cornus canadensis 2.1 Maianthemum canadense 2.1 Pteridium aquilinum, var. latiusculum 1.1 moss spp. 3.3

382. Emli Dlzp.sr Hlp Glr Bzr
Picea rubens 5.1 Abies balsamea 1.1 Picea glauca +.1 Betula papyrifera 2.1 Acer rubrum 2.1 Acer pensylvanicum +.1 Gaylussacia baccata 1.3 Vaccinium angustifolium 3.3 Vaccinium Vitis-Idaea, var. minus +.3 Cornus canadensis 3.3 Maianthemum canadense 2.1 Pteridium aquilinum, var. latiusculum 1.3 Aster umbellatus +.2 Danthonia spicata +.2 Deschampsia flexuosa +.2 Kalmia angustifolia 1.3

383. Emli Hlp Glp
Picea glauca 5.1 Picea rubens 1.1 Pteridium aquilinum, var. latiusculum 2.1 Aralia nudicaulis 2.1 Maianthemum canadense 1.1 Festuca sp. 3.3 Pyrus melanocarpa +.1

384. El.zp Dz.lsr Hmlp Lp Glr bp Bzp
Picea rubens 4.1 Pinus Strobus 1.1 Juniperus communis, var. depressa 2.3 Thuja occidentalis +.1 Gaylussacia baccata 5.4 Vaccinium angustifolium 3.3 Betula papyrifera 1.1 Acer rubrum 1.1 Viburnum cassinoides 1.1 Pteridium aquilinum, var. latisculum 1.1 lichen spp. (mostly Cladonia) 2.3 Danthonia spicata +.2 Deschampsia flexuosa +.2 Kalmia angustifolia 2.3

385. Dmi.lsp.zr Emlp Hlp Lp
Acer rubrum 4.1 Betula papyrifera 2.1 Acer spicatum +.1 Acer pensylvanicum +.1 Vaccinium angustifolium 1.3 Picea rubens 3.1 Abies balsamea 1.1 Thuja occidentalis +.1 Cornus canadensis 1.1 Maianthemum canadense 1.1 Pteridium aquilinum, var. latiusculum 1.3 Dryopteris noveboracensis +.3 moss spp. 2.3

386. Dsz Elp Nlp Hml Gmp Lp
Alnus rugosa, var. americana 1.1 Acer rubrum 1.1 Betula papyrifera 2.1 Myrica Gale 3.1 Chamaedaphne calyculata, var. angustifolia 2.1 Ilex verticillata 3.1 Thuja occidentalis 2.1 Larix laricina 1.1 Sarracenia purpurea 2.2 Osmunda regalis, var. spectabilis 3.1 Hypericum virginicum, var. Fraseri +.1 Aster nemoralis 2.1 Solidago uliginosa +.1 Carex rostrata 2.4 Carex lenticularis 2.4 Calamagrostis canadensis 1.2 Juncus canadensis +.2 Sphagnum sp. 2.3

387. Eli.mp Dlp
Picea rubens 4.1 Betula papyrifera 2.1 Acer rubrum 1.1

388. Dmlsi Elp Hmp
Acer rubrum 3.1 Quercus rubra, var. borealis 1.1 Betula papyrifera 2.1 Betula populifolia 2.1 Populus grandidentata 1.1 Acer pensylvanicum 1.1 Fagus grandifolia +.1 Rubus allegheniensis 3.3 Picea rubens 2.1 Pinus Strobus 1.1 Pteridium aquilinum, var. latiusculum 1.3 Aralia hispida 1.1 Trientalis borealis +.1

389. Em
Picea rubens 5.1

390. Dz.sp Hmp
Betula papyrifera 2.1 Betula populifolia 2.1 Populus grandidentata 2.1 Prunus pensylvanica 1.1 Acer rubrum 1.1 Comptonia peregrina 2.3 Pteridium aquilinum, var. latiusculum 1.3 Aralia hispida 1.2 Solidago canadensis +.2

391. Dsz Lp
Betula papyrifera 4.1 Betula populifolia 3.1 Acer rubrum 2.1 Populus grandidentata 1.1 Acer pensylvanicum 1.1 Salix discolor 1.1 Prunus pensylvanica 1.1 Polytrichum sp. 3.3

392. Emp Dmzp.si Lp bp
Tsuga canadensis 2.1 Pinus Strobus 2.1 Picea rubens 2.1 Betula lutea 2.1 Betula papyrifera 1.1 Sambucus pubens 2.1 Prunus pensyl-

vanica 1.1 Acer spicatum 1.1 Rubus idaeus, var. strigosus 1.1 moss spp. 2.3 Rubus allegheniensis +.1 Diervilla Lonicera 1.2

393. Dz Glp Hlp Lp bp
Betula populifolia 4.1 Betula papyrifera 1.1 Vaccinium angustifolium 2.3 Comptonia peregrina 2.2 Deschampsia flexuosa 1.2 Danthonia spicata 1.2 Pteridium aquilinum, var. latiusculum 1.2 Potentilla tridentata +.1 Solidago sp. +.1 Polytrichum sp. 2.3

394. Eli Dzp
Pinus rigida 4.1 Betula populifolia 4.1 Vaccinium angustifolium 2.3 Gaylussacia baccata 1.3

395. Dlszp.mr Emlr Glp Hlr Lp
Betula populifolia 3.1 Betula papyrifera 2.1 Acer rubrum 2.1 Betula lutea 1.1 Acer saccharum +.1 Acer pensylvanicum 1.1 Viburnum cassinoides 1.1 Prunus pensylvanica 1.1 Vaccinium angustifolium 2.3 Diervilla Lonicera 1.2 Gaylussacia baccata 1.2 Rubus allegheniensis 1.1 Rubus idaeus, var. strigosus 1.1 Picea rubens 1.1 Deschampsia flexuosa 2.3 Danthonia spicata 1.2 Calamagrostis canadensis 1.3 Carex crinita 1.2 Osmunda Claytoniana 1.2 Solidago canadensis 1.2 Potentilla tridentata 1.2 Aster umbellatus +.1 Solidago Randii +.1 Aralia hispida +.1 moss spp. 2.2

396. Dl.sp Elr Glp Hlp
Betula populifolia 3.1 Betula papyrifera 2.1 Acer saccharum 1.1 Fagus grandifolia 2.1 Acer rubrum 1.1 Acer pensylvanicum 1.1 Populus tremuloides 1.1 Picea rubens 2.1 Osmunda—Dryopteris—Aralia—Viola—Aster—Hieracium—etc. etc.

397. Dlszp.mr Emlr Glp Hmlp
Betula papyrifera 2.1 Betula populifolia 2.1 Acer rubrum 2.1 Populus grandidentata 1.1 Populus tremuloides 1.1 Quercus rubra, var. borealis 1.1 Acer pensylvanicum 1.1 Fraxinus americana 1.1 Prunus pensylvanica 1.1 Salix discolor 1.1 Viburnum cassinoides 1.1 Spiraea latifolia 1.1 Comptonia peregrina 2.2 Diervilla Lonicera 1.2 Rubus allegheniensis 1.1 Vaccinium angustifolium 1.3 Pinus Strobus 1.1 Danthonia spicata 2.2 Agrostis tenuis? 1.2 Aster macrophyllus 1.3 Aster umbellatus 1.1 Solidago canadensis 1.1 Solidago graminifolia 1.1 Pteridium aquilinum, var. latiusculum 1.2 Hieracium pratense 1.1

398. Dl.sp Elp Hlp Glp
Betula populifolia 4.1 Betula papyrifera 2.1 Populus grandidentata +.1 Corylus cornuta 1.1 Picea rubens 2.1 Pinus Strobus 2.1 Abies balsamea 1.1 Thuja occidentalis 1.1 Hieracium pratense 2.1 Aster umbellatus 1.1 Pteridium aquilinum, var. latiusculum 1.1 Aster macrophyllus 1.1 Danthonia spicata 2.2

399. Dl.sp Elr Hmlp Glp Lp
Betula papyrifera 3.1 Betula populifolia 3.1 Acer saccharum 1.1 Fagus grandifolia 1.1 Acer pensylvanicum 2.1 Picea rubens 2.1 Aster umbellatus 1.1 Hieracium pratense 1.1 Solidago canadensis 1.1 Solidago graminifolia +.1 Danthonia spicata 1.2 Agrostis tenuis? 1.2 moss spp. 1.3

400. Emli Dmli.sp
Picea rubens 3.1 Tsuga canadensis 2.1 Thuja occidentalis 2.1 Fagus grandifolia 2.1 Acer saccharum 2.1 Acer rubrum 2.1 Acer pensylvanicum 4.1

401. Dlsi Elr Hmlp
Betula papyrifera 3.1 Betula populifolia 3.1 Populus grandidentata 1.1 Acer saccharum 1.1 Acer rubrum 1.1 Acer pensylvanicum 2.1 Prunus pensylvanica 1.1 Picea rubens 1.1 Pteridium aquilinum, var. latiusculum 2.1 Aralia hispida 1.1 Aster macrophyllus +.1 Solidago Randii +.1

402. Eml Dmlp Hlp Lp
Abies balsamea 4.1 Picea rubens 2.1 Betula papyrifera 2.1 Betula populifolia 1.1 Acer rubrum 1.1 Fraxinus americana +.1 Fagus grandifolia +.1 Betula lutea 1.1 Acer saccharum +.1 Maianthemum canadense 2.1 Cornus canadensis 2.1 moss spp. 4.4

403. Dz.sp.lr Hmlp Gmp Lp
Betula papyrifera 3.1 Betula populifolia 3.1 Populus tremuloides 1.1 Salix discolor 1.1 Acer rubrum 1.1 Acer pensylvanicum 1.1 Rubus idaeus, var. strigosus 1.1 Aster umbellatus 2.1 Solidago canadensis 1.1 Solidago graminifolia 1.1 Solidago rugosa 1.1 Aralia hispida 1.1 Anaphalis margaritacea, var. intercedens 1.3 Scirpus cyperinus, var. pelius 2.3 Carex crinita 1.2 Lycopodium sp. 3.3

404. Dsz.lr Hmp
Betula papyrifera 4.1 Betula populifolia 2.1 Populus grandidentata 1.1 Salix discolor 2.1 Rubus idaeus, var. strigosus 2.1 Rubus allegheniensis 2.1 Solidago canadensis 1.1 Anaphalis margaritacea, var. intercedens 1.3

405. Dml Elp Gm Hmlp L
Acer rubrum 3.1 Fraxinus americana 3.1 Betula papyrifera 1.1 Betula lutea 1.1 Picea rubens 2.1 Abies balsamea 2.1 Thuja occidentalis 1.1 Calamagrostis canadensis 4.4 Carex crinita 1.2 Dryopteris noveboracensis 3.3 Onoclea sensibilis 1.2 Cornus canadensis 1.1 Viola pallens? 1.1 Sphagnum sp. 4.3

406. Dms Emr
Fagus grandifolia 2.1 Acer saccharum 2.1 Fraxinus americana 1.1 Betula papyrifera 2.1 Betula populifolia 1.1 Betula lutea +.1 Acer rubrum 2.1 Acer pensylvanicum 3.1 Picea rubens 1.1

407. Eml Dlr Hlr Lp
Picea rubens 5.1 Betula papyrifera 1.1 Acer rubrum 1.1 Acer pensylvanicum 1.1 Thuja occidentalis 1.1 Maianthemum canadense 1.1 Pteridium aquilinum, var. latiusculum +.1 Aralia nudicaulis +.1 moss spp. 2.2

408. Dmls Elsp Hlr Lp
Betula lutea 3.1 Betula papyrifera 2.1 Acer rubrum 2.1 Acer saccharum 1.1 moss spp. 2.2 Fraxinus americana 1.1 Fagus grandifolia 1.1 Acer pensylvanicum 2.1 Picea rubens 2.1 Abies balsamea 1.1 Aralia nudicaulis 1.1

409. Eml Dsr Lp
Picea rubens 5.1 Tsuga canadensis 1.1 Thuja occidentalis +.1 Acer pensylvanicum 1.1 Acer rubrum +.1 moss spp. 3.3

410. Dzp Bzp Hlp Glp Elr Lp bp
Pyrus melanocarpa 3.3 Vaccinium angustifolium 2.3 Alnus crispa, var. mollis +.1 Betula populifolia +.1 Kalmia angustifolia 2.3 Potentilla tridentata 1.2 Arenaria groenlandica +.2 Hypericum gentianoides +.3 Danthonia spicata 2.2 Deschampsia flexuosa 1.2 Picea rubens +.1 Cladonia spp. 3.3

411. Emli Dlszp Hmlp Glp Lr
Picea rubens 4.1 Betula papyrifera 2.1 Acer rubrum 2.1 Acer pensylvanicum 2.1 Populus grandidentata +.1 Vaccinium angustifolium 2.3 Pteridium aquilinum, var. latiusculum 3.1 Aralia nudicaulis 1.1 Danthonia spicata 1.2 moss spp. 2.2 lichen spp. +.2

412. Dlsi Elp Glp bp
Betula papyrifera 3.1 Acer pensylvanicum 1.1 Quercus rubra, var. borealis 1.1 Betula lutea +.1 Acer spicatum 1.1 Picea rubens 1.1 Deschampsia flexuosa 1.2 Polypodium virginianum +.1

413. Dms Emlp Lr
Betula papyrifera 3.1 Acer rubrum 2.1 Acer pensylvanicum 2.1 Betula lutea 1.1 Fagus grandifolia +.1 Picea rubens 3.1 Abies balsamea 2.1 moss spp. 1.2

414. Emli Dlsp Hlp Lp
Picea rubens 4.1 Pinus Strobus 2.1 Abies balsamea 1.1 Betula papyrifera 2.1 Acer rubrum 2.1 Acer pensylvanicum 2.1 Acer saccharum 1.1 Maianthemum canadense 1.1 Pteridium aquilinum, var. latiusculum +.1 moss spp. 1.2

415. Dml.sp Elp Hmlp
Betula papyrifera 3.1 Acer rubrum 3.1 Acer saccharum 1.1 Acer pensylvanicum 1.1 Betula lutea 1.1 Alnus rugosa, var. americana 1.1 Abies balsamea 2.1 Picea rubens 1.1 Osmunda cinnamomea 1.2 Osmunda Claytoniana 1.2 Dryopteris noveboracensis 1.3 Aster umbellatus 1.1

416. Emlp Dlszp Nmr Hmlp Bzr
Picea rubens 3.1 Abies balsamea 1.1 Picea mariana 1.1 Acer rubrum 3.1 Betula papyrifera 2.1 Vaccinium angustifolium 1.3 Nemopanthus mucronata 2.1 Ilex verticillata 2.1 Viburnum cassinoides 1.1 Spiraea latifolia 2.1 Rhododendron canadense 1.1 Kalmia angustifolia 1.2 Larix laricina 1.1 Osmunda cinnamomea 2.1

417. Dmli Elp.mr Hml Gmr Lp
Betula papyrifera 3.1 Acer rubrum 3.1 Fagus grandifolia 2.1 Betula lutea 1.1 Picea rubens 2.1 Abies balsamea 1.1 Dryopteris noveboracensis 2.3 Aster umbellatus 2.1 Cornus canadensis 1.1 Maianthemum canadense 1.1 Solidago rugosa 1.1 Onoclea sensibilis +.2 Hieracium pratense +.1 Carex crinita +.2 Agrostis tenuis +.2 Polytrichum sp. 2.2

418. Dml.sp Elp
Betula papyrifera 3.1 Fagus grandifolia 2.1 Acer rubrum 2.1 Acer pensylvanicum 1.1 Betula lutea +.1 Picea rubens 3.1

419. Dml.sp Elp Hmlp Lp
Acer rubrum 3.1 Betula papyrifera 3.1 Fraxinus americana 1.1 Viburnum cassinoides 1.1 Alnus rugosa, var. americana 1.1 Picea rubens

2.1 Abies balsamea 2.1 Osmunda Claytoniana 2.2 Pteridium aquilinum, var. latiusculum 2.4 Aster umbellatus 2.1 Aster macrophyllus 1.1 Maianthemum canadense 2.1 moss spp. 3.3

420. Dmls Emr
Betula papyrifera 3.1 Betula lutea 2.1 Fraxinus americana 2.1 Acer pensylvanicum 2.1 Acer saccharum +.1 Fagus grandifolia +.1 Populus grandidentata +.1 Acer rubrum 3.1 Picea rubens +.1

421. Dls Els
Betula populifolia 3.1 Betula papyrifera 2.1 Prunus pensylvanica 1.1 Thuja occidentalis 3.1

422. Dm.sp Elp
Betula papyrifera 3.1 Acer saccharum 2.1 Fagus grandifolia 2.1 Acer pensylvanicum 2.1 Picea rubens 3.1

423. Dml.sp Emlp
Acer rubrum 3.1 Acer pensylvanicum 3.1 Fagus grandifolia 2.1 Betula papyrifera 2.1 Betula lutea 1.1 Fraxinus americana 1.1 Picea rubens 2.1 Abies balsamea 1.1

424. Emli Dmlp.si
Picea rubens 4.1 Abies balsamea 1.1 Betula papyrifera 2.1 Fagus grandifolia 1.1 Acer pensylvanicum 4. 1

425. Dmls Emlp
Betula papyrifera 3.1 Acer rubrum 3.1 Fraxinus americana 1.1 Acer pensylvanicum 1.1 Fagus grandifolia +.1 Picea rubens 2.1

426. Dli.sp Eli Hmlp
Acer rubrum 4.1 Betula papyrifera 1.1 Ilex verticillata 1.1 Nemopanthus mucronata 1.1 Viburnum cassinoides 1.1 Thuja occidentalis 4.1 Abies balsamea 3.1 Picea rubens +.1 Aster umbellatus 2.1 Osmunda Claytoniana 1.3 Aster macrophyllus 1.1 Dryopteris noveboracensis +.3 Pteridium aquilinum, var. latiusculum 1.3

427. Dl.sp Eli Hmli
Acer rubrum 4.1 Betula papyrifera 1.1 Betula lutea 1.1 Nemopanthus mucronata 1.1 Ilex verticillata 1.1 Viburnum cassinoides 1.1 Thuja occidentalis 4.1 Abies balsamea 3.1 Picea rubens 1.1 Osmunda Claytoniana 1.3 Aster umbellatus 2.1 Aster macrophyllus 1.1 Pteridium aquilinum, var. latiusculum 1.3 Dryopteris noveboracensis +.3

428. Eml Dlp Hlp
Pinus Strobus 4.1 Picea rubens 2.1 Acer rubrum 1.1 Betula papyrifera +.1 Cornus canadensis 2.1 Maianthemum canadense 2.1 Pteridium aquilinum, var. latiusculum 1.2

429. Dlszp Elp Hmlp Glp Bzr Lp bp
Betula populifolia 3.1 Betula papyrifera 2.1 Acer rubrum 2.1 Acer pensylvanicum 2.1 Acer spicatum 1.1 Amelanchier laevis 1.1 Viburnum cassinoides 1.1 Gaylussacia baccata 1.3 Vaccinium angustifolium 2.3 Pyrus melanocarpa 1.3 Picea rubens 2.1 Abies balsamea 1.1 Thuja occidentalis 1.1 Aster umbellatus 2.1 Pteridium aquilinum, var. latiusculum 2.1 Aralia nudicaulis 1.1 Hypericum gentianoides +.2 Potentilla tridentata +.2 Danthonia spicata 1.2 Deschampsia flexuosa 1.2 Kalmia angustifolia 1.3 lichen spp. 2.3

430. Dl.sp
Fagus grandifolia 4.1 Betula papyrifera 2.1 Acer rubrum 1.1 Fraxinus americana +.1 Acer pensylvanicum 3.1 Acer saccharum 1.1 Betula lutea 1.1

431. Dmli.sp Emlp Hlr Lp
Betula papyrifera 2.1 Fagus grandifolia 2.1 Acer saccharum 1.1 Acer rubrum 1.1 Acer pensylvanicum 2.1 Fraxinus americana +.1 Picea rubens 3.1 Thuja occidentalis +.1 Tsuga canadensis +.1 Aralia nudicaulis 1.1 moss spp. 3.2

432. Dml Elp.mr
Fagus grandifolia 3.1 Betula papyrifera 2.1 Acer saccharum 2.1 Acer rubrum 2.1 Fraxinus americana 1.1 Betula lutea 1.1 Acer pensylvanicum 2.1 Picea rubens 3.1 Abies balsamea 2.1 Thuja occidentalis 1.1

433. Eml Dlp Hmr Lp
Picea rubens 5.1 Thuja occidentalis 2.1 Betula papyrifera 2.1 Acer rubrum 1.1 Acer saccharum +.1 Fraxinus americana +.1 Betula lutea +.1 Acer pensylvanicum 1.1 Osmunda Claytoniana 1.3 moss spp. 2.3

434. Dlszp Elp.mr Glp Hmlp Bzr Lp bp
Betula papyrifera 1.1 Betula populifolia 1.1 Acer rubrum 1.1 Viburnum cassinoides 2.1 Spiraea latifolia 2.1 Vaccinium angustifolium 2.3 Diervilla Lonicera 1.2 Gaylussacia baccata 2.3 Picea rubens 2.1 Picea glauca 1.1 Deschampsia flexuosa 2.2 Danthonia spicata 2.2 Aster umbellatus 2.1 Potentilla tridentata 1.2 Pteridium aquilinum, var. latiusculum 2.3 Kalmia angustifolia 1.3 lichen spp. 2.3

435. Dlsi Emlp Hmlp Glp Lr bp
Acer rubrum 3.1 Betula papyrifera 3.1 Acer pensylvanicum 1.1 Viburnum cassinoides 2.1 Prunus pensylvanica 1.1 Spiraea latifolia 1.1 Vaccinium angustifolium 2.4 Picea rubens 2.1 Abies balsamea 2.1 Aster umbellatus 1.1 Pteridium aquilinum, var. latiusculum 2.2 Cornus canadensis 2.2 Maianthemum canadense 1.1 Aster acuminatus 1.1 Deschampsia flexuosa 1.2 Danthonia spicata 1.2 lichen spp. 1.3

436. Eml Dmlp Hlp Lp
Picea rubens 5.1 Acer rubrum 2.1 Betula papyrifera 2.1 Acer pensylvanicum 2.1 Cornus canadensis 1.1 Maianthemum canadense 1.1 Clintonia borealis +.1 Aster macrophyllus +.1 Aralia nudicaulis +.1 moss spp. 2.3

437. Dm.lp Eli.mr Hl
Acer rubrum 3.1 Betula papyrifera 3.1 Picea rubens 3.1 Abies balsamea 2.1 Maianthemum canadense 4.1 Clintonia borealis 2.1 Aralia nudicaulis 1.1

438. Eml L
Picea rubens 5.1 Picea glauca 1.1 moss spp. 4.4

439. Dl.sp Eli Hlp Lp
Acer rubrum 4.1 Betula papyrifera 3.1 Acer pensylvanicum 1.1 Populus grandidentata 1.1 Fraxinus americana +.1 Abies balsamea 4.1 Picea rubens 2.1 Maianthemum canadense 1.1 Pteridium aquilinum, var. latiusculum 1.1 moss spp. 2.3

440. Hm Gm Li Dsr
Solidago graminifolia 4.1 Onoclea sensibilis 1.1 Osmunda cinnamomea 1.1 Osmunda Claytoniana 1.1 Dryopteris noveboracensis 1.3 Rubus hispida 2.1 Carex gracillima 3.1 Luzula multiflora 1.1 Scirpus cyperinus, var. pelius 1.1 Carex crinita 1.1 Sphagnum spp. 4.4 Spiraea tomentosa 1.1 Alnus rugosa, var. americana 1.1

441. El.mp Dlp Hlp Lp
Picea rubens 5.1 Pinus Strobus 1.1 Abies balsamea 3.1 Betula papyrifera 2.1 Acer rubrum 2.1 Maianthemum canadense 1.1 Pteridium aquilinum, var. latiusculum +.1 Aralia nudicaulis 1.1 Trientalis borealis +.1 moss spp. 2.3

442. Emli Dli.sp Hlp Lp
Picea rubens 4.1 Pinus Strobus 1.1 Abies balsamea 1.1 Acer rubrum 3.1 Betula papyrifera 2.1 Acer pensylvanicum 1.1 Cornus canadensis 1.1 Maianthemum canadense 1.1 Pteridium aquilinum, var. latiusculum 1.1 Aralia nudicaulis 1.1 moss spp. 2.2

443. Dszp.lr Emlzr Glp Hmp Lp bp
Betula papyrifera 2.1 Acer rubrum 1.1 Gaylussacia baccata 1.3 Pyrus melanocarpa +.2 Vaccinium angustifolium 1.3 Picea rubens 1.1 Juniperus communis, var. depressa 1.3 Pinus rigida 1.1 lichen spp. 2.3 Deschampsia flexuosa 1.2 Danthonia spicata +.2 Pteridium aquilinum, var. latiusculum 1.3 Aralia hispida 1.1 Potentilla tridentata +.2

444. Elp.zr Dzp Hlr Lp
Pinus rigida 4.1 Juniperus communis, var. depressa 1.3 Gaylussacia baccata 1.3 Vaccinium angustifolium 1.3 Pyrus melanocarpa +.2 Aralia hispida 1.1 Potentilla tridentata +.2 lichen spp. 2.3

445. Dl.sp Eli Hlp Lp
Acer rubrum 4.1 Acer pensylvanicum 2.1 Betula papyrifera 1.1 Abies balsamea 4.1 Picea rubens 1.1 Thuja occidentalis +.1 Aster macrophyllus 3.3 Aralia nudicaulis 2.1 Cornus canadensis 2.1 Maianthemum canadense 1.1 Pteridium aquilinum, var. latiusculum 1.1 moss spp. 2.3

446. Dml.sr El.mr Hlp Li
Acer rubrum 3.1 Betula papyrifera 3.1 Acer pensylvanicum 1.1 Thuja occidentalis 4.1 Abies balsamea 2.1 Picea rubens 1.1 Trientalis borealis 2.1 Cornus canadensis 2.1 moss spp. 4.4

447. Gm Dszp
Calamagrostis canadensis 4.5 Danthonia spicata 1.4 Juncus canadensis 1.3 Populus tremuloides 2.1 Betula populifolia 1.3 Spiraea latifolia 1.3 Salix discolor +.1

448. Emlp Nmlp Dlzp
Picea mariana 3.1 Abies balsamea +.1 Larix laricina 3.1 Betula populifolia 1.1 Vaccinium angustifolium 3.3 Comptonia peregrina 2.3

449. Gl Hmp Dlsp
Poa pratensis 3.2 Phleum pratense 3.2 Agropyron repens 1.2 Agrostis alba 1.4 Festuca rubra +.2 Hypericum perforatum 2.3 Solidago canadensis 2.2 Betula populifolia 2.4 Pyrus malus and Pyrus communis planted

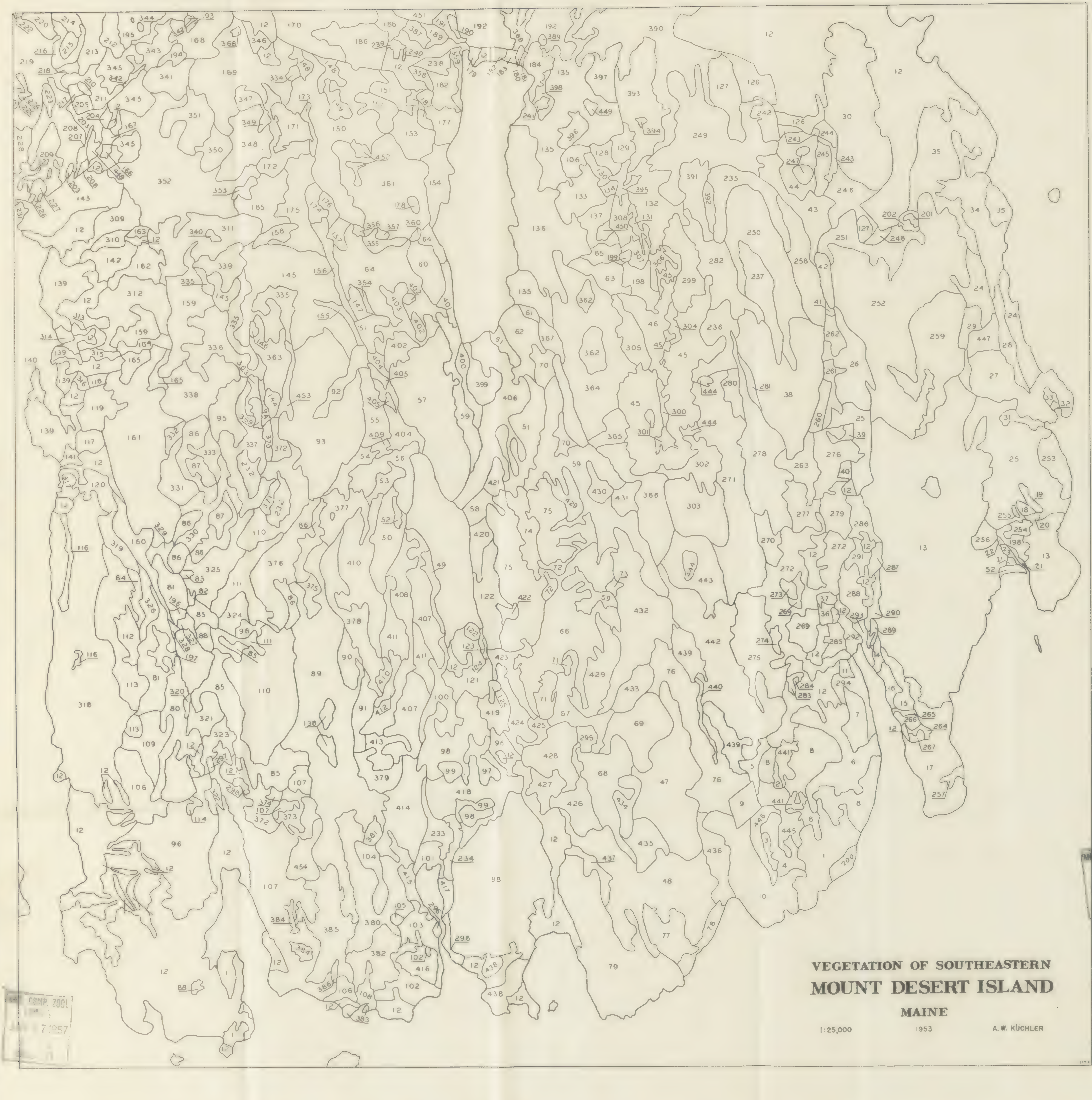
450. Dli Elp
Betula papyrifera 3.1 Acer rubrum 3.1 Picea rubens 1.1

451. Dz Glp Hlp Lp
Betula populifolia 5.1 Betula papyrifera 1.1 Fagus grandifolia 1.1 Prunus pensylvanica 1.1 Acer rubrum 1.1 Vaccinium angustifolium 1.3 Populus tremuloides +.1 Spiraea latifolia 1.1 Rubus idaeus, var. strigosus 3.3 Rubus allegheniensis 3.3 Comptonia peregrina +.3 Danthonia spicata 1.3 Festuca capillata 1.2 Pteridium aquilinum, var. latiusculum 1.1 Solidago canadensis 1.1 Solidago rugosa 1.1 Polytrichum sp. 3.3

452. Eml Nlp
Thuja occidentalis 4.1 Pinus Strobus +.1 Picea mariana +.1 Larix laricina 2.1

453. Dli.sp Gm Hmp
Acer rubrum 4.1 Betula populifolia 1.1 Viburnum cassinoides 1.1 Nemopanthus mucronata 1.1 Alnus crispa, var. mollis 1.1 Pyrus americana +.1 Aster umbellatus 3.1 Calamagrostis canadensis 3.4 Brachyelytrum erectum, var. septentrionale 1.3 Carex gracillima 2.2

454. El Dzp Bzp Hlp Glr Lp
Picea rubens 5.1 Betula populifolia 1.1 Betula papyrifera 1.1 Gaylussacia baccata 1.3 Vaccinium angustifolium 1.2 Kalmia angustifolia 3.3 Cornus canadensis 3.3 Danthonia spicata 1.2 Agrostis scabra +.2 Cladonia spp. 2.3



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Biological and Systematic Studies of Two Species of Cheyletid Mites, with a Description of a New Species (Acarina, Cheyletidae) *

BY

ROBERT E. BEER and DAVID T. DAILEY

ABSTRACT: Studies of the developmental stages of two species of cheyletid mites are reported in this paper. One of these species is new to science. In addition there is included a discussion of the taxonomy and morphology of these species as well as detailed remarks on rearing methods used.

Mites of the family Cheyletidae are segregated into nineteen genera, two of which are represented by species discussed in this work. *Cheyletus eruditus* (Schrank) a cosmopolitan species, has on numerous occasions been reported in the literature especially regarding its predatory habits, yet its complete developmental history has been unrecorded prior to the publication of this paper. The new species here described is a member of the genus *Cheletophyes* and is the second North American species to be described in this genus.

INTRODUCTION

The objective of this study was twofold. First, an effort was directed toward establishing the unequivocal identity, in all of its developmental stages, of a cheyletid mite species that apparently not only extends its range over a large area of the world, but quite possibly may be one of the most beneficial species in the family because of its predatism on many important pests. Second, it was hoped that some techniques developed in the rearing and observing of predaceous mite species might be recorded for use by others working with live cultures of predatory acariens.

The mite family Cheyletidae contains nineteen genera that are distinguished largely on the basis of characters of the dorsal shields, and on palpal and pretarsal structure and ornamentation. In the genus *Cheletophyes* five species have been described from various parts of the world, the species here concerned being the second from North America. C. *hawaiiensis* Baker is recorded from Kailua, Oahu, Hawaii; C. *marshalli* Baker was described from specimens taken at Imboden, Arkansas; C. *phillippinensis* Baker from Bataan, Philippine Islands; C. *semenovi* Kuzin from Uzbekistan, U. S. S. R.; C. *vitzthumi* Oudemans from Willomore, Cape Colony, Africa. To the knowledge of the present authors there are no published accounts of biological observations of any members of the genus.

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* Contribution No. 893 from the Department of Entomology, University of Kansas.

The genus *Cheyletus* contains approximately thirty species, the uncertainty of the exact complement of the genus being due to the inclusion of some questionable species. *Cheyletus eruditus* (Schrank) is apparently a cosmopolitan species, being recorded from Europe, Asia, South America, Greenland and the United States.

The biology of C. *eruditus* has been investigated in America by Ewing (1912) and in England by Newstead *et al.* (1918). The species of mite studied by Beck (1866), whose work was repeated and confirmed by M'Intire (1869), had a life cycle very similar to that of C. *eruditus* and may have been this species. Some account was taken of this mite's life stages in connection with biological studies of predaceous mite species, Gause, *et al.* (1936), and on studies of interrelations between phytophagous and predaceous mites by Rodionov (1940).

C. *eruditus* has frequently aroused the interest of entomologists due to its usual role as a predator of arthropods associated with stored grains and foods. Some tests and observations have been made regarding its potential value in biological control of such pests. Ewing (1912), Newstead *et al.* (1918), Siggaard (1920), Redikortzev (1924), Rodionov (1937, 1940), Solomon (1946), and others contributed papers wherein biological observations of this type were recorded. Rennie and Harvey (1922-1923) state that the species probably is a valuable predator of *Tarsonemus aphis* Rennie, *Gamasus* sp., and *Rhizoglyphus echinopus* Fumouze and Robin, when in situations where these species are destructive in bee nests. The mite has been found in stocks of bees infested with *Acarapis woodi* (Rennie), where, according to Homann (1933), it was thought to be feeding on the stocks of "wet-mold" mites rather than on the actual bee parasites.

Cheyletus eruditus (Schrank) has some medical and veterinary history. Pierce (1921) states that otoacariasis is caused in man by this species attacking the external auditory meatus and Riley and Johannson (1938) state that the mite has been taken in a pus discharge from the ear of man. An outbreak of dermatitis among American troops in North Wales reported by Hill and Gordon

(1945) was thought to involve *C. eruditus.* When searching for the cause, they discovered two species of rodent mites in the troops' bedding and two additional species in the palliasses used by the troops. *C. eruditus* was found only in the stockpile of straw used for stuffing the palliasses. The authors point out that rodent mites may have been the primary cause of this dermatitis in humans. Pillers (1920) lists *C. eruditus* as an accidental parasite in the ears of the domesticated rabbit and guinea pig in association with mites of the families Acaridae and Parasitidae and also mentions *C. eruditus* as the causal agent for a skin eruption in horses.

A detailed description of the adult female and developmental stages of *Cheyletus eruditus* and of both sexes and the developmental stages of *Cheletophyes knowltoni* are presented in a portion of this paper that follows. Rearing and observation techniques used in this study are also discussed in detail as an aid to persons engaged in similar studies.

REARING METHODS

The majority of specimens obtained for this study were collected in conventional berlese traps. Litter of straw and other detritus on the earth floor of an abandoned barn in Lawrence, Kansas was found to be heavily populated with the two species reported upon in this paper. The trapping jar beneath the funnel was prepared with a mixture of plaster of Paris and activated charcoal, utilizing the recipe of Farrell and Wharton (1949), poured to a depth of one inch. The plaster was kept moist during trapping operations after the early discovery that both species were extremely sensitive to desiccation. The cheyletids were removed from the trap jars at frequent intervals and placed in rearing pens.

The stender dish type rearing pens, prepared in the manner described by Lipovsky (1953a), were used only for mass culturing of the species being studied and for containing individual specimens in the deutonymphal or adult stages. For individual rearing of larvae and protonymphs, stender dishes having an outside diameter of 35 mm. and a depth of 18 mm. were used.

Preparation of a substrate within the rearing dish was accomplished as follows: The jar was filled with a mixture of plaster of Paris and charcoal, mixed in the proportion of 500 to 60 respectively by weight. The jar was filled to a depth of one fourth of an inch, the mixture then wetted and allowed to set. While soft, some of the mixture was plastered on the sides of the rearing pen to form a thin, even film about the inside of the pen, terminating about one eighth of an inch from the top. Charcoal was added to the plaster of Paris to make the substrate more porous, so that when water was added during culture of the mites, it would sink immediately into the substrate and not leave a drop of moisture which might drown the mites. As *C. eruditus* is quite pale in color in all immature stages, the dark color given to the substrate by the addition of charcoal made it much easier to find the mites.

The plaster-charcoal substrate provided a roughened surface which is necessary in order that cheyletids may move freely and easily after their prey, [noted by Kozulina (1940)], and it also provided a method of keeping the relative humidity in the rearing pen within tolerable limits. However, it was found that humidity was not an important limiting factor in the adult stage, as *C. eruditus* will tolerate a relative humidity of thirty to thirty-five per cent for four to five days which confirmed observations of Rodionov (1940). The adults of *Cheletophyes knowltoni* seemed to be as resistant to desiccation as the adults of *Cheyletus eruditus*.

Before the substrate had hardened after being wetted in the rearing pen, a narrow depression was scratched in the bottom of the plaster to give the mites a hiding place. *C. eruditus* would not feed nor remain quiet unless such a place of concealment was provided. This practice was early discontinued, however, as it was possible for mite larvae and protonymphs to hide or molt under overhanging lips of such depressions and escape detection. As a substitute, a bit of paper or other foreign material was introduced into the chamber which seemed to be quite adequate for the purposes mentioned. To complete the rearing pen, a small amount of vaseline was spread around the top of the rearing pen and then the lid was pressed firmly into place and rotated until a firm and air-tight "seat" was effected. The vaseline also served as a repellent to *Cheletophyes knowltoni*. The rearing pen remained near laboratory temperature (approximately 80-85° F.) which was within the tolerance limits for *C. eruditus*. Rodionov (1937) reports the mite living at a temperature of 95° F. in laboratory culture.

In order to keep large cultures of predaceous mites in the laboratory, it was necessary also to rear large numbers of mites as a source of food. *Tyrophagus* sp. (Acaridae) was tried and found to be very useful for this purpose. These acarids have a high reproductive potential, are easily kept in the mass culture pens mentioned above and need to be fed only once a week with a bit of dried yeast. It was not necessary to add water to this type of culture.

As described by M'Intire (1869), acarids may occasionally attack cheyletids and overpower them, resulting in the death of the latter. This situation in culturing *C. eruditus* became a problem only at the time of molting. At that time, if the rearing pen held a number of semistarved acarids, regardless of the state of development, they would attack the molting cheyletid and feed upon it, usually resulting in the death of the cheyletid. Semistarved acarids in any appreciable quantity were dangerous to *Cheletophyes knowltoni*, regardless of whether the cheyletid was active or molting and regardless of the stage of development. Although the cheyletid was much more agile, the acarids would surround and overpower the mite, killing it in a short time. In one case a female *C. knowltoni* was placed in an individual rearing pen with ten acarids in varying stages of development and within two hours the cheyletid had been overpowered and a number of the acarids were feeding upon her. Within five hours the larger acarids had left the cheyletid and acarid larvae were devouring what remained of the cheyletid with the exception of legs and palps. In practice, when *Cheletophyes knowltoni* was observed in the premolt condition, all acarids were removed from the rearing pen.

Cheyletids of both species involved, cultured in individual rearing pens, were fed once a day. A microneedle mounted in a glass handle made a very serviceable instrument for the transferring of individual acarids from stock culture to rearing pen.

For the keeping of individual records of the cheyletids reared, ruled five-by-eight note cards were used. The plain side of the card was ruled into squares for the daily entry of such information as feeding and molting data. The ruled side of the record card was kept for such information as to where the mite was obtained, dates for stages in the life history, records of activities, etc. The cards were kept in a convenient file box and were identified with numbers corresponding to the numbers fastened to the lids of the rearing pens.

Mites to be mounted were cleared in a commercial solution of lactophenol, and if stained, a ten-percent solution of acid fuchsin was used. The specimens were then mounted in polyvinyl alcohol (PVA) containing lactophenol in the manner described by Lipovsky (1953b). Specimens were flattened to some degree in order to project the legs satisfactorily.

DESCRIPTIONS AND BIOLOGICAL NOTES

Cheyletus eruditus (Schrank)

Acarus eruditus Schrank, 1781, Enumeratio insectorum Austriae indigenorum, p. 513.

Eutarsus cancriformis Hessling, 1852, Illustr. Med. Zeit., vol. 1, p. 258. Oudemans, 1938, Tijdschr. voor Ent., vol. 81, p. lxxv.

Cheyletus seminivorus Packard, 1878, Guide to the study of insects, (Henry Holt and Co., New York), p. 665. (new synonymy). Ewing, 1909, Illinois Univ. Studies, vol. 3, pp. 76-77; 1912, Jour. Econ. Ent., vol. 5, pp. 416-420.

Cheyletus ferox Banks, 1906, Proc. Ent. Soc. Washington, vol. 7, p. 134.

Cheyletus eburneus Hardy, 1933, (in Andre), Ann. des Epiphyt., vol. 19, pp. 336, 344, 350.

Cheyletus eruditus (Schrank), Oudemans, 1903, Tijdschr. voor Ent., vol. 46, pp. 118-129; 1906, Mem. Soc. Zool. France, vol. 19, pp. 84-88. Newstead and Duvall, 1918, Reports of the Grain Pests (War) Committee, no. 2, pp. 14-16. Haarløv, N., 1942, Medd. Grønland, no. 1281, p. 171. Hughes, 1948, The mites associated with stored food products, Ministry of Agriculture and Fisheries, London, pp. 102-105. Baker, 1949, Proc. U. S. Natl. Mus., vol. 99, no. 3238, p. 278.

This is a robust, active mite, light yellow to orange in color as a young adult, darkening to brown with age. The immature forms are white to light yellow in color, the deutonymph becoming light brown toward the end of the stadium. The female has two dorsal plates while the immature stages have only the anterior dorsal plate present. The dorsum, with the exception of the gnathosoma, is finely striated where not covered by a plate. The mite is widest at the region of the shoulder setae, tapering rearward. Structural characteristics of the setae on the legs seem to vary from specimen to specimen, from finely pilose setae to simple setae. The degree of ornamentation for a given seta will be stated only when it is seen to be constant throughout the specimens examined.

Female: (Plate I, figures 1-4)—Length of body, 360-410μ; including rostrum, 527-637μ. Width of body 286-332μ. Palpus stout; femur two-thirds as broad as long with convex outer margin and nearly straight inner margin, the long dorsal seta situated near mid-segment minutely and sparsely pilose, its length about equal to length of segment, two small simple setae located ventrally on segment, one near inner basal angle, the other near outer apical angle of segment; genu short, nearly three times as broad as long, a long minutely pilose seta located dorsally near outer margin of segment, its length exceeding width of segment; tibia twice as broad at base as at apex, the inner margin with pronounced concavity extending from basal third of segment to apex, the tarsus adjoining tibia along posterior half of declivity of this inner tibial margin, tibia bears a simple dorsal seta one and one-half times as long as segment situated on inner margin near mid-segment, and a strong slightly curved blunt claw with two stout protuberances near its inner basal margin, the claw more than one and one-half times as long as tibia and emanating, with its basal protuberances, from narrowed apex of tibia; tarsus small, as broad as long, outer tarsal comb borne at apex of segment, with thirteen to fourteen teeth, these decreasing in size toward base, inner tarsal comb attached to inner basal margin of segment, about one-half as long as outer comb, with fourteen to seventeen teeth with largest teeth in center of comb, segment with two long simple ventral setae; palpal coxa robust, as broad as long, with one simple ventral seta near apex; trochanter very short, without setae. Rostrum simple, narrow, broadening rearward, with two dorsolateral setae distally, two short ventrolateral setae subapically; peritreme segments bent to form letter M, four to five segments lying between spiracle and longitudinally directed limb. Dorsal propodosomal shield rounded anteriorly, widening posteriorly, covering most of propodosoma, with four pairs of narrow lanceolate pilose marginal setae, three pairs at anterior angles, one pair at posterior angles. One pair of lanceolate pilose setae on dorsum between propodosomal shield and hysterosomal shield. One pair of long lanceolate, finely pilose, dorsolateral shoulder setae between legs II and III. Hysterosomal shield trapezoidal, with rounded angles, shield slightly longer than wide, wider anteriorly, smaller than propodosomal shield, with three pairs of narrow lanceolate pilose marginal setae, one pair at anterior angles, one pair toward rear, one pair at posterior angles. One pair of lanceolate, pilose dorsal setae situated subterminally on opisthosoma. Venter of propodosoma with two pairs of submedian setae, first pair located mesad from coxae I, second pair posteromesad from coxae II. Venter of hysterosoma with two pairs of submedian setae, first pair mesad from coxae IV, second pair posteromesad from coxae IV. Venter of opisthosoma with two pairs of setae on either side of anterior extremity of vulvular opening, two pairs of lanceolate setae on folds of vulvular opening. One pair of lanceolate, finely pilose setae on terminal margin of opisthosoma; anal opening surrounded by four minute stout curved bristles. Coxae I, III and IV, each with two setae; coxa II with one seta; trochanters I, II and IV, each with one seta; trochanter III with two setae; femora I, II, III and IV, each with two setae; genua I, II, III and IV, each with two finely pilose setae; genu I with a small rod-shaped seta located dorsally at apex; tibia I with a small rod-shaped seta and one pilose lanceolate seta; tibiae I, II, III and IV, each with four unclothed lanceolate setae; tarsus I with sensory seta about one-fourth as long as tarsus, one simple guard seta, one-half as long as sensory seta; tarsi I, II, III and IV, each with one finely pilose seta in center of segment, two long simple setae at distal end of segment, terminal on tarsus I, substerminal on tarsi II, III and IV, two small finely pilose setae at distal end of segment flanked by two short simple setae; tarsi I, II, III and IV, each terminate with an empodium flanked by two small, recurved claws. Tarsus I, 107μ long; tibia I, 71μ long. Leg I, 416μ long; leg IV, 387μ long.

Larva: (Plate II, figures 5-7)—The larva has been described and figured by Newstead and Duvall (1918, pp. 13-14, figure 3). A redescription follows: Length of body, 156-241μ; including rostrum, 202-307μ. Width of body, 94-158μ. Palpus slender; femur about one and one-half times as long as wide, with convex outer margin, dorsal seta finely and sparsely pilose, about as long as segment; genu with a dorsal pilose seta; tibia with two ventrolateral setae and a dorsal seta at distal end of segment, claw slightly bent, no protuberances at base; tarsus with two subterminal, sicklelike, ventral setae, outer tarsal comb with twelve teeth of equal size, inner tarsal comb with ten teeth, outer tarsal comb about two times as long as inner tarsal comb. Rostrum simple, narrow, broadening rearward, with two dorsolateral setae distally, two short, ventrolateral setae distally; peritreme segments bent to form letter M. Propodosomal shield rounded anteriorly, widening posteriorly, covering most of propodosoma, with four pairs of narrow, lanceolate, pilose, marginal setae; one pair of dorsal, pilose setae near posterior angles of shield; one pair of dorsolateral, lanceolate, shoulder setae. Dorsum of hysterosoma with three transverse rows of pilose setae, first row with two pairs, remaining rows with one pair each. Venter of propodosoma with one pair of setae mesad from coxae I. Venter of hysterosoma with two pairs of setae, one pair mesad from coxae III, one pair laterad from anus. Legs subequal in size; coxa I with one seta; coxae II and III bare; trochanters I, II and III bare; femora I, II and III, each with two setae; genua I and III, each with a simple seta; genu II with a pilose seta; tibia I with a short sensory seta; tibiae I, II and III, each with four simple setae; tarsus I with one guard seta one-half as long as tarsus, one sensory seta about as long as guard seta, one finely pilose seta, two lanceolate terminal setae unequal in length, two short terminal setae; tarsi II and III, each with two subterminal setae, two short simple terminal setae, two short terminal finely pilose setae; tarsi I, II and III, each terminate with an empodium flanked by two small, recurved claws. Length of tarsus I, 50μ; length of tibia I, 23μ. Length of leg I, 154μ; length of leg III, 145μ.

Protonymph: (Plate II, figures 8-10)—The protonymph has been described and figured by Oudemans (1903, pp. 123-124, figure 34). A redescription follows: Length of body, 277-298μ; including rostrum, 359-385μ. Width of body, 192-214μ. Palpus stout; femur about as broad as long with convex lateral margin, segment with two ventrolateral setae the outer seta pilose, the inner simple, and one dorsal seta finely pilose and longer than segment; genual seta on posterior margin of segment, finely pilose; tibia with two ventrolateral setae and one seta at distal end of segment; a strong claw slightly bent, with two protuberances of equal size at base surmounts segment; tarsus with outer tarsal comb having twelve to fourteen teeth, teeth decreasing in size toward base, inner tarsal comb with eight to ten teeth decreasing in size toward base; outer tarsal comb about one and one-half times as long as inner tarsal comb; coxa with a simple ventral seta near apex; trochanter very small and unornamented. Rostrum simple, broadening posteriorly, with two dorsolateral setae distally, two short, ventrolateral setae distally, peritreme segments bent to form letter M, four to five segments lying between spiracle and longitudinally directed limb. Propodosomal shield rounded anteriorly, widening posteriorly, with five pairs of lanceolate pilose marginal setae, three pairs toward anterior angles, two pairs toward posterior angles; one pair of lanceolate, finely pilose, dorsolateral, shoulder setae between legs II and III; four transverse rows of lanceolate, finely pilose setae on dorsum of hysterosoma, each row with two pairs of setae. Venter of propodosoma with two pairs of lanceolate setae, one pair mesad from coxae I, second pair posteromesad from coxae II. Venter of hysterosoma with six pairs of lanceolate setae, one pair mesad from coxae IV, one pair posteromesad from coxae IV, anus flanked by four pairs of setae; one pair of terminal pilose setae. Coxae I and III, each with two setae; coxa II with one seta; coxa IV bare; trochanters I, II and IV bare, trochanter III with two setae; femora I, II, III and IV, each with two setae; genua I, II, III and IV, each with two setae; tibia I with one short rodlike seta, two lanceolate setae, three finely pilose setae; tibiae II, III and IV, each with four finely pilose setae; tarsus I with one sensory seta about one-half as long as segment, one simple, guard seta about one and one-half times as long as sensory seta; tarsi I, II, III and IV, each with one finely pilose seta in center of segment, two long simple setae distally on segment, two small pilose setae at distal end of segment flanked by two short simple setae. Tarsus I, 58μ long; tibia I, 31μ long. Leg I, 222μ long; leg IV, 190μ long.

Deutonymph: (Plate II, figures 11-13)—The deutonymph has been described and figured by Oudemans (1903, pp. 124-125, figure 38). A redescription follows: Length of body 240-321μ; including rostrum, 356-449μ. Width of body 148-235μ. Palpus robust; coxa with a simple ventral seta near apex; femur longer than wide, with convex lateral margin, segment with two ventrolateral setae, the inner simple, the outer seta finely pilose and about as long as segment; genu with one ventrolateral, median seta and one finely pilose seta on posterior margin of segment; tibia with two ventrolateral setae, a dorsal tibial seta at distal end of segment and a stout terminal claw slightly bent with two equal protuberances at base; outer tarsal comb about two times as long as inner tarsal comb, with eleven to thirteen teeth, these decreasing in size toward base; inner tarsal comb with twelve to thirteen teeth, decreasing in size toward base; tarsus with two subterminal ventral sicklelike setae. Rostrum simple, narrow, broadening rearward, with two dorsolateral setae distally, two short ventrolateral setae distally; peritreme segments bent to form letter M, four to five segments lying between spiracle and longitudinally directed limb. Propodosomal shield rounded anteriorly, widening posteriorly, covering most of propodosoma dorsally, with four pairs of finely pilose marginal setae, three pairs at anterior angles, one pair at posterior angles, two pairs of submedian finely pilose setae toward caudal margin of shield. One pair of long lanceolate finely pilose dorsolateral shoulder setae between legs II and III laterad from shield. Dorsum of hysterosoma with four transverse rows of finely pilose setae, four setae in a row, lateral setae longer than median setae. Venter of propodosoma with two pairs of setae, first pair mesad from coxae I, second pair mesad from coxae II. Venter of hysterosoma with two pairs of submedian setae, first pair mesad from coxae IV, second pair posteromesad from coxae IV; anal opening flanked by four pairs of simple setae; one pair of pilose setae laterad from anus; one pair of subterminal, pilose, ventrolateral setae at distal end of hysterosoma. Coxae I, III and IV, each with two finely pilose setae; coxa II with one pilose seta; trochanters I, II and IV, each with two finely pilose setae; trochanter III with one finely pilose seta; femora I, II and III each with two finely pilose setae; femur IV with one pilose seta; genua I, II, III and IV each with two finely pilose setae; genu I with a short rod-shaped seta distally; tibiae I and II each with four finely pilose setae; tibiae III and IV each with three finely pilose setae; tibiae I, III and IV each with a simple, lanceolate seta; tibia I with a short, rod-shaped seta distally; tarsi I, II, III and IV each with a pilose seta in center of segment, two long, simple setae distally, two small, pilose setae flanked distally by two short simple setae; tarsus I with a sensory seta about one-half as long as segment, guard seta simple, about one and one-half times as long as sensory seta; tarsi I, II, III and IV, each terminates with an empodium flanked by two small recurved claws. Tarsus I, 85μ long; tibia I, 47μ long. Leg I, 310μ long; leg IV, 280μ long.

Type locality: Austria.

Location of type: Unknown.

Type habitat: Unknown.

Distribution: The species has been recorded from Australia, Holland, India, Portugal, Mexico, Scotland, Jugoslavia, England, Germany, Japan, Colombia, Chile, Brasil, Greenland and the United States. In the United States it has been taken from house sparrows at Ithaca, New York, on *Sciurus carolinensis* at Thomasville, Georgia, and from California, Minnesota, and Oregon in warehouses, in grains. The description of the female and immature forms is based on material taken in stable litter from cattle barns at Lawrence, Kansas.

Cheyletus eruditus was found to be entirely predaceous, feeding on almost any arthropod small or weak enough to be overpowered. It has been observed feeding on tineid larvae one fourth of an inch long, adult psoccids and various collembolans, to mention the larger prey. The mite has not been observed feeding on spiders or Acarina of the families Uropodidae, Oribatidae, or Bdellidae, even when the cheyletid was in a state of semistarvation and these arachnids abundant.

The mite was cannibalistic by nature. In mass cultures the larger forms were often seen feeding on smaller active stages of the same species, and nymphal forms were observed feeding on the eggs of their own species. Adults kept in the same pen without a sufficient food supply battled savagely with one another, the victor feeding on the vanquished. The species would by preference, however, attack the smallest and weakest prey conveniently available.

This species usually would not feed unless it had a small pit or cut on the substrate in which to hide. It would remain at the opening of the depression with palps widespread, ready to seize any prey which ventured near. Rarely would it dash from the pit to catch a victim which did not pass close enough to be seized from ambush. As had been reported by Ewing (1912), the mite, if not starved, often fed a bit and then released its victim which would survive if too great a quantity of the victim's blood had not been removed. The present authors found that *C. eruditus* often would feed a bit on five or six different acarid adults during the course of an afternoon and all of these acarids usually survived the assault. However, if the predator was starved, it might completely drain an adult female acarid in as little as twenty minutes, leaving only an empty, shriveled skin.

If no pit was provided, the mite would lie in ambush under a piece of paper or any such concealment that was provided within the pen. If no method of concealing itself was available, the mite would usually wander about until it became stuck in the vaseline at the top of the rearing pen. While wandering about looking for a place of concealment the mite was quite timid, rushing wildly from arthropods smaller than itself, no matter how defenseless they might be.

Once entrenched in a hiding place, the cheyletid seemed able to cope only with arthropods approaching it from the front. If in some manner acarid larvae or other small and defenseless prey were introduced to the rear of the pit, the cheyletid would, upon being touched by the prey, jump forward or sideways. It was assumed that it was searching for the source of the stimulation. Being unable to find the cause of stimulation to the front or sides, the cheyletid would move from the hiding place and usually move to a new location. On the rare occasions that it returned to the original spot, the prey would be devoured if the cheyletid entered the pit head first. However, if the mite backed into the pit and was again stimulated by the prey which had remained in the pit, the same procedure of searching forward and sideways followed by leaving the pit, was repeated.

The mite would, if possible, grasp a leg of its prey with the strong palps and having inserted its needlelike chelicerae, suck the body fluids from the victim with powerful pumping movements of the pharynx. In the case of acarids, the body fluids could be seen through the transluscent body wall as they flowed down the leg into the cheyletid. If a leg was not caught at the first thrust, the predator would usually seize its victim by any part of the body, inserting its chelicerae in whatever portion of the anatomy that was readily available. Observations of great numbers of individual feedings seemed to indicate that a definite preference was shown by the cheyletid to grasp the victim by a leg and feed from this appendage.

It is doubted that the mite in any stage of the life history produced venom or toxic saliva. This assumption rests on the fact that arthropods attacked by *C. eruditus* often recovered from the attack of the predator as discussed above, and also victims usually continued escape attempts, flexing the legs and body parts while being fed upon, and if released shortly after the predator started to feed, seemed to recover fully from the attack.

C. eruditus seemed sensitive to light, making immediate attempts to escape from the more strongly illuminated parts of the pen. If the mite was within a hiding spot, it would withdraw as far as possible into the dark. Mites running loose on the substrate would invariably attempt to reach a dark portion of the rearing pen. It is possible that this was a reaction to the heat accompanying the illumination, but the same reaction was observed when the pen was illuminated by daylight in a cool, humid atmosphere.

The mite usually molted in the section of the pen where it normally lived. There was a premolt period which varied in duration for the different instars. During this premolt period the mite refused all food and its movements were inclined to be sluggish.

The mite was not observed actually assuming the molting position, but once settled, the position of the mite was prone on the substrate, dorsum up, with legs I and II directed forward at full length. This was a very typical position and was only assumed at the time of molting.

This species was not observed in copulation. During the course of this work, no males were taken from berlese funnels nor reared from eggs. All agamic eggs from laboratory cultures produced females.

Adult behavior. About forty-eight to sixty hours after emergence of the female, egg-laying commenced. A maximum of twenty-two eggs was laid over a period of seven days by one female. The most frequent procedure was for the female to lay eleven eggs at a time. The eggs were generally laid in a depression or under a bit of foreign material and were deposited in a cluster, but not fastened together nor fastened to the substrate. The eggs had no strands of silk or other material covering them. The female gradually moved forward as the eggs were deposited, making an oblong pile. Eleven eggs could be laid in about twelve hours. After laying a quota of eggs, the female would stand guard over them for about twenty-four hours, palps spread in a defensive attitude, and would rush forward and repeatedly pinch any object presented. No attempt to feed was made during this period. Occasionally, while the eggs were being deposited, an acarid would move up behind the female and feed on the eggs as they were laid. So long as the acarid did not touch the cheyletid and moved slowly, it was not molested. One such acarid was prodded with a needle at such a time, the disturbance being enough to greatly excite the cheyletid which rushed from the pit, turned around and entered it head foremost and rapidly drove the acarid from the pit with repeated pinchings of legs and body of the intruder.

About seven days from the time of the first egg-laying, ten to eleven more eggs usually were deposited as described and guarded for the same length of time. The female would then live for some time, actively feeding but on no occasion were more eggs laid.

Egg-laying may be extended over a period of thirty days, two to three eggs being laid every other day or so until the full complement was reached, although some females reared have laid as few as four eggs during their life span. When laid in such a manner, the eggs may or may not be guarded by the female. Irregular egg deposition seemed to be caused by the availability of food. If the female was not fed after emergence, only two to five eggs might be laid, and if still not fed, the female would die without laying any additional eggs. However, if given ample food after the initial starving, a further complement of eggs was usually laid. One female laid four eggs and then fifty-seven days later deposited five additional eggs. During this entire period the female had ample food.

The length of the adult stadium varied widely in the laboratory, running from twenty-five to eighty-three days. However, the last few days before a normal death, the mite would be very feeble with poor co-ordination and rarely took food. About a week before death, drops of some clear exudate became visible, scattered over the body of the mite. This exudate was quite viscous, debris of all kinds adhering to it. The exudate seemed to be formed regardless of the relative humidity of the rearing pen.

The eggs were semitransparent, shiny and oblong-oval in shape being about two thirds as broad as long when laid. The eggs averaged 125μ in length and 90μ in width.

Egg:—The eggs laid in small batches, that were usually left unprotected after laying, were often preyed upon by mites of the families Acaridae and Tydeidae. In the mass rearing jars used for

Cheyletus eruditus various immature forms of other predatory mites were occasionally seen to feed on the eggs if there was a dearth of other food.

At temperatures of 80-85°F., the eggs hatched after two to four days, averaging three days. The process of hatching was fairly rapid, taking about thirty minutes. The rostrum was forced through the egg shell and moved from side to side a bit until an opening, large enough to allow the palps to protrude, was formed. Legs I were slowly projected from this opening, one at a time, in a continuous movement. Simultaneously, the palps and rostrum were prying on the substrate in such a manner as to urge the body forward. At about the same time, the forepart of the body was forced through the opening which continued to grow larger. The larvae seemed to push the forepart of the body from the shell by repeatedly contracting the body, which was followed by an active expansion and pushing forward of the body. Legs II eventually were released, one at a time, and fastened to the substrate. At this time legs III could be seen through the egg shell taking an active part in pushing the body forward. The mite always paused for a few moments after the anterior portion of the body was out of the shell and then would ease the remainder of the body from the shell and move some distance away.

Occasionally a mite would be found with one or more legs projecting through small holes that the legs had torn in the egg shell. Mites in this condition never emerged, although they have been seen struggling to do so for as long as seventy-two hours before death terminated the futile struggle to escape from the shell.

Larva:—The larva was able to move speedily about immediately after leaving the egg but seemed inclined to stay close to the location of hatching for five to eight hours; no food was taken during this period. Later it moved about on the substrate until a suitable hiding place was found. The larva would back into the hiding place and remain quiet with the palps projecting. The mite then would attack passing animals only if they made no threatening advances. The larva was extremely timid and would attack larvae much smaller than themselves only after many timid advances and retreats. The larva must have done much traveling about when not under observation, because if a number of larvae were confined in a rearing pen without ample food, within a short while there would be only one or two individuals remaining, . . . undeniable evidence of their cannibalistic habits.

The larvae were fed on the larvae and first nymphal instars of *Tyrophagus* sp., but usually in order to induce them to feed under observation, it was necessary to place the prey in the pit or depression with the larval form of *C. eruditus* and then replace the lid of the rearing pen for a short period, or else reduce the illumination of the pen very greatly. When observed a short time later, the larval predator usually would be feeding.

Six to twelve hours before molting the larva would take no food and would be very sluggish in its movements. No larvae were actually observed assuming the molting position although the typical attitude of forward extension of legs I and II was assumed before the ecdysis. The larval stadium at 80°-85° F. was from three to six days with an average of four days.

Protonymph: The protonymph emerged after a twenty-four hour molting period. The larval skin would split transversely on the dorsum, the line of suture being between legs II and III of the larval skin. During emergence legs IV were not used, but were held upward and rearward from the body with the genual and tibial segments appressed to these same segments of the opposite leg. The tarsi were free and could be seen flexing. The length of time the rear legs were held in this position is not known, but twelve hours after completing emergence they were in a normal position and were functional in locomotion.

The protonymph often refused food for about five to eight hours after emergence. Some tried to feed soon after emergence, but the palps did not seem to be hardened enough to hold the prey and, in one instance where the prey (*Tyrophagus* sp., larva) remained quiet, the predator's chelicerae did not seem to be able to pierce the body wall of the prey.

Protonymphs were fed on larvae and small nymphal instars of *Tyrophagus* sp. It was rare for a protonymph to attack prey its own size or larger. If several of the same age were confined in the same pen they were highly cannibalistic, however.

The protonymphal stadium at 80°-85° F. was from four to eight days, averaging five days, the nymph molting within the depression where it normally sought shelter. As in the larva, food was refused for some time (six to twelve hours) before molting actually began. The protonymph was not observed assuming the molting position, though the characteristic stance was invariably taken before ecdysis.

Deutonymph: Immediately after emergence, the deutonymph would usually refuse food. Occasionally, one would attempt to feed soon after emergence but, as in other stages, the palps did not seem strong enough to hold the prey.

Deutonymphs were fed *Tyrophagus* sp. nymphs and males, but an attempt to feed them nymphs or females larger than themselves was usually unsuccessful. Toward the end of the deutonymphal stadium, the mite would often attack adult acarids or cheyletids, if these adults were in a weakened condition.

From the remains of prey found scattered about in the rearing pens, it is assumed that the deutonymphs moved about considerably, when not under observation, in the darkened rearing chambers. However, the deutonymph always seemed to return to the pit or debris selected for a hiding place, as they would normally be found in that location.

The deutonymph would molt in that portion of the rearing pen selected as its retreat after going through a premolt period of six to twelve hours. During this period it would take no food. The mite was not seen assuming the molting position. The deutonymphal stadium at 80°-85° F. was from eight to ten days, averaging nine days.

Cheletophyes knowltoni, sp. nov.

Superficially this species resembles *Cheletophyes hawaiiensis* Baker and *C. marshalli* Baker, but examination of the female will show distinct differences. *Cheletophyes knowltoni* is unique in having but one tooth on the palpal claw. The dorsal palpal femoral setae are rodlike and spinose. The tarsus of leg I has a rodlike sensory seta about one-half as long as the segment, with a finely spinose guard seta twice as long as the sensory seta. There are five spinose setae and one short peglike sensory seta on tibia I.

Observed under low magnification the dorsolateral body setae appear as flattened whitish subclavate frondlike erect structures.

The mite is orange to pink in color as an adult, the immature stages varying from yellow to orange. Legs I of all stages seem to be used as tactile organs and are not used to support the body. There is, in the adult stage, a single anterior and a single posterior dorsal plate. The nymphal stages have one anterior and two small posterior dorsal plates, while an anterior dorsal plate only is present in the larval stage. There is a dorsal rostral shield present on all active stages.

Female: (Plates III and IV, figures 14-16, 20)—Length of body, 384μ; including rostrum, 576μ; width of body, 287μ. Palpus robust;

coxa robust, with one simple ventral seta near apex; trochanter small, unornamented; femur about as broad as long, strongly convex on outer margin, inner margin slightly concave, with two rodlike dorsal spinose setae, one ventrolateral lanceolate spinose seta and two ventrolateral simple setae; genu short and broad, unadorned; tibia as broad at base as long, inner margin with deep declivity at basal fourth of segment, width of segment decreasing from declivity to apex, segment with one dorsolateral simple seta situated near inner margin at base of segment, one long minutely pilose seta located near mid-segment at apical third; palpal claw long curved slender, acuminate at tip, with a single stout blunt tooth on inner margin at basal third of claw; tarsus small knoblike, as broad as long, with one apical short peglike seta on tubercle, two apical whiplike setae; two apical tarsal combs, the outer comb with twenty-three teeth, teeth decreasing in size toward base, comb stouter and longer than inner comb, inner comb with forty-two teeth, decreasing in size toward base. Rostrum with dorsal shield; forepart of shield split from spiracle forwards, notched distally on inner margins, longitudinally striated; rear part of shield extending to anterior margin of propodosoma, longitudinally striated, fine punctations in striations; peritreme simple, with elongate segments; rostrum with a pair of ventrolateral simple setae distally and a pair of short dorsolateral simple setae subapically. Single pair of eyes. Anterior dorsal shield large, covering most of propodosoma, rounded anteriorly, widening posteriorly, with four pairs of long marginal subclavate spinose setae, three pairs at anterior angles near eyes, one pair at posterior angles; shield coarsely striated. A pair of long subclavate spinose dorsolateral shoulder setae located slightly laterad from posterolateral angles of anterior dorsal shield. Posterior dorsal shield large, covering most of hysterosoma, broadest in front, rounded posteriorly, about equal in length to anterior shield; shield with five pairs of long marginal subclavate spinose seta, two pairs at anterior angles, two pairs at posterior angles, one pair located submesally at distal end of shield; shield coarsely striated; a pair of stout subclavate spinose setae located terminally at apex of opisthosoma behind shield. Dorsum of idiosoma with five pairs of submedian staghorn setae, two pairs on anterior dorsal plate, three pairs on posterior dorsal plate. Venter of propodosoma with two pairs of submedian simple setae, first pair located anteromesad from coxae I, second pair posteromesad from coxae II. Venter of hysterosoma with three pairs of submedian simple setae located in linear arrangement between coxae IV and anterior extremity of vulva; vulva flanked posteriorly by a pair of small triangular genital plates each with rounded angles and bearing a pair of small simple setae. Anal plate small and subtriangular, its broad anterior margin slightly concave, posterior angle notched distally, with two short pilose setae and a transverse row of four simple setae distributed along anterior margin of plate, the medial setae shorter than lateral setae. Coxa I with two simple ventral setae; trochanter I with one lanceolate spinose seta; femur I with two spinose setae; genu I with two long spinose setae; tibia I with three long spinose setae subbasally, a very long (224μ) spinose seta distally, a long spinose seta subdistally, and a peglike sensory seta distally; tarsus I as illustrated. Coxa II with one simple seta; trochanter II with one spinose seta; femur II with two spinose setae; genu II with two spinose setae; tibia II with a simple sensory seta three times as long as segment and three spinose setae; tarsus II with a short peglike sensory seta at apical fourth of segment, a spinose seta at midsegment, a pair of simple setae terminally and a pair of finely spinose setae subterminally; tarsus II terminates in a fringed empodium flanked by two short recurved claws. Coxa III with two setae, one simple, one spinose; trochanter III with two spinose setae; femur III with two spinose setae; genu III like genu II; tibia III with three spinose setae and a simple seta; tarsus III lacking short peglike sensory seta, otherwise like tarsus II. Coxa IV with two simple setae; trochanter IV with one spinose seta; femur IV with one spinose seta; genu IV like genu II; tibia IV like tibia III; tarsus IV like tarsus III; pretarsal elements as on leg III. Length of tarsus I, 156μ; length of tibia I, 144μ. Length of leg I, 700μ; length of leg IV, 560μ.

Male: (Plate V, figures 21-23)—Length of body, 306μ; including rostrum, 500μ; width of body, 230μ. Palpus robust; femur broadly rounded on outer margin, about as broad as long, with two simple ventral setae, two stout spinose dorsal setae and one stout spinose ventrolateral seta; genu without ornamentation; tibia with two simple setae, one dorsal and one ventral, and one ventral spinose seta; palpal claw short, curved, slender, with a single large blunt tooth at basal third of claw; tarsus with one apical short peglike seta on tubercle, two apical simple whiplike setae; two apical tarsal combs, the outer comb stouter and larger than inner comb, outer comb with twenty-two teeth decreasing in size toward base, inner tarsal comb with forty teeth decreasing in size toward base; coxa with one ventral simple seta near trochanter; trochanter small, unornamented. Rostrum robust, its dorsal shield extending rearwards to propodosoma, longitudinally striated; anterior portion of shield lightly punctate; rostrum with a pair of ventrolateral simple setae distally and a pair of dorsolateral simple setae subapically; peritreme simple, segments elongate, two to three segments between spiracle and longitudinally directed member. Single pair of eyes located laterad from third setae of anterior shield. Dorsum of idiosoma almost completely covered by the two large dorsal plates; anterior plate about three-fifths as long as posterior plate, both plates projecting laterad nearly to margins of body. Anterior shield rounded anteriorly, posterior extremity slightly wider than anterior extremity. Posterior shield with hind margin rounded-truncate and anterior margin broadly and angularly truncate. Six pairs of large subclavate spinose setae distributed on lateral margins of plates, three on anterolateral angles of anterior plate, one on posterior angles of anterior plate, one at mid-length of posterior plate, one on posterolateral angle of rear plate. Five pairs of large subclavate spinose setae arranged in two longitudinal rows on dorsal plates submesally, two on posterior third of anterior plate the remaining three pairs on posterior plate. Two pairs of stout subclavate spinose setae located dorsally on idiosoma but not on dorsal plates, one of these slightly anterior to juncture of anterior and posterior shields, the other borne subterminally on opisthosoma in linear alignment with mesal setae of plates. Venter of idiosoma with two longitudinal rows of small simple setae, the first pair just mesad to coxae I, the second anteromesad from coxae III, the remaining three pairs posteromesad from coxae IV. Genital opening dorsoterminal on opisthosoma with two pairs of small hooked setae situated laterad from orifice and one pair of minute setae located dorsally just anterior to orifice; two pairs of small dorsal setae each borne on a minute plate, located between posterior margin of the large posterior dorsal plate and the cluster of setae around genital orifice. Aedeagus lancetlike. Coxa I with two simple setae; trochanter I with one stout subclavate spinose seta; femur I with two stout subclavate spinose setae; genu I with two rodlike spinose setae, unequal in length; tibia I with three subclavate spinose setae located on basal fourth of segment, one sensory seta subdistally, about one fifth as long as segment, two subclavate spinose setae subdistally, one very long (227μ); tarsus I as illustrated. Coxa II with one simple seta; trochanter II with one subclavate spinose seta; femur II with two setae, one subclavate spinose, the other lanceolate finely pilose; genu II with two subclavate spinose setae; tibia II with one long rodlike sensory seta twice as long as segment, three long subclavate spinose setae, one lanceolate finely pilose seta; tarsus II with a short spinelike sensory seta and a subclavate spinose supporting seta distally on segment, two subterminal simple setae, four subterminal short finely pilose setae; tarsus II terminating in a fringed empodium flanked by two small recurved claws. Coxa III with one subclavate, spinose seta, one lanceolate simple seta; trochanter III with two pilose setae; femur III with two subclavate spinose setae; genu III like genu II; tibia III like tibia II; tarsus III without short spinelike sensory seta, otherwise like tarsus II; pretarsal elements as on leg II. Coxa IV with two simple setae; trochanter with one subclavate spinose seta; femur IV with one subclavate spinose seta; genu IV like genu III; tibia IV like tibia III; tarsus IV like tarsus III; pretarsal elements as on leg II. Length of tarsus I, 136μ; length of tibia I, 146μ. Length of leg I, 672μ; length of leg IV, 508μ.

Larva: (Plate IV, figures 17-19)—Length of body, 146μ; including rostrum, 208μ; width of body, 132μ. Palpus and rostrum robust; palpal femur rounded laterally, about as wide as long, with one dorsal clavate spinose seta; no dorsal genual seta; one dorsal tibial seta finely pilose; palpal claw long, slender, slightly curved, with a single tooth at basal fourth; tarsus with two apical whiplike setae, two ventrolateral setae, the outer finely spinose, the inner smooth, segment with two combs, outer tarsal comb longer and stronger than inner comb, with twelve teeth adorning basal two thirds of comb, teeth decreasing in size toward base, inner tarsal comb with twenty-seven teeth distributed along entire length of comb, teeth decreasing in size toward base. Rostrum with dorsal plate extending posteriorly to anterior margin of propodosoma, deeply emarginate anteriorly, finely punctate; peritreme simple with elongate segments, two to three segments between spiracle and longitudinally directed member; rostrum with one pair of simple ventrolateral setae distally. Single pair of eyes. Anterior dorsal plate large, covering most of propodosoma, rounded anteriorly, widened posteriorly, with three pairs of marginal subclavate spinose setae at anterior angles near eyes, one pair of submedian subclavate spinose setae on posterior margin of plate; entire plate finely punctate. One pair of dorsal subclavate spinose setae near but not on posterolateral angles of propodosomal plate and one pair of dorsolateral lanceolate spinose shoulder setae situated slightly laterad from these setae. Dorsum of hysterosoma with four transverse rows of subclavate spinose setae; first row with four setae, second, third and fourth rows with two setae each; dorsal body surface of entire hysterosoma striated. Venter of propodosoma with one pair of submedian simple setae, situated mesad from coxae I. Venter of hysterosoma with two pairs of submedian simple setae, situated mesad from coxae IV and laterad from anus; anus flanked by three pairs of simple setae. Coxa I with one simple seta; trochanter I bare; femur I with two spinose setae, unequal in length; genu I with one spinose seta; tibia I with three spinose setae and one simple seta; tarsus I as illustrated. Coxa II bare; trochanter II like trochanter I; femur II with two setae, one spinose and one simple; genu II like genu I; tibia II like tibia I; tarsus II with one small peglike, sensory seta located distally on segment, two simple subapical setae, four short, finely pilose setae apically, segment terminated by a fringed empodium flanked by two small recurved claws. Coxa III like coxa II; trochanter III like trochanter I; femur III with one spinose seta; genu III like genu I; tibia III like tibia I; tarsus III without short peglike sensory seta, otherwise like tarsus II. Length of tarsus I, 75μ; length of tibia I, 26μ. Length of leg I, 205μ; length of leg III, 128μ.

Protonymph: (Plate VI, figures 24-26)—Length of body, 251μ; including rostrum, 342μ; width of body, 189μ. Palpus and rostrum robust; palpal femur rounded on outer margin, one simple seta and two dorsal rodlike spinose setae; genu bare; tibia with two long and one short setae, the long seta minutely pilose; palpal claw long, curved, slender, with a single prominent tooth at basal third; tarsus small knoblike, with two apical whiplike setae, two apical tarsal combs, the outer comb with fifteen teeth arranged on basal half of comb, teeth decreasing in size toward base, outer comb stouter and longer than inner comb, the inner comb with thirty-six teeth distributed along entire length of comb, teeth decreasing in size toward base; coxa with one simple, ventral seta. Rostrum with dorsal shield extending rearward to anterior margin of propodosoma, forepart broadly emarginate; shield finely punctate; peritreme simple, segments elongate, two to three segments between spiracle and longitudinally directed limb; rostrum with a pair of ventrolateral simple setae distally, one pair of shorter, dorsolateral simple setae subapically. Single pair of eyes. Anterior dorsal plate large, covering most of propodosoma, rounded anteriorly, broadening posteriorly, finely punctate, with four pairs of marginal subclavate spinose setae, three pairs at anterior angles near eyes, one pair at posterior angles; one pair of submedian subclavate spinose setae near posterior margin of plate. One pair of long subclavate spinose, dorsolateral, shoulder setae between legs II and III. Dorsum of hysterosoma with five horizontal rows of long subclavate spinose setae; anterior row with four setae, each borne on a minute plate, second row with two setae, each borne on a small distinct plate, third, fourth and fifth rows with two setae each; all six of the small dorsal hysterosomal plates finely punctate. Dorsum of hysterosoma finely striated in regions not covered by plates. Venter of propodosoma with two pairs of submedian simple setae, one situated mesad from coxae I, the other posteromesad from coxae II. Venter of hysterosoma with a pair of submedian simple setae, situated posteromesad from coxae IV; terminal anal opening flanked by four pairs of short simple setae. Coxa I with two simple setae; trochanter I bare; femur I with one clavate spinose seta and one subclavate spinose seta; genu I with two subclavate spinose setae; tibia I with four subclavate spinose setae and one short peglike seta; tarsus I as illustrated. Coxa II with one simple seta; trochanter II like trochanter I; femur II with one subclavate spinose seta and one simple seta; genu II like genu I; tibia II with three subclavate spinose setae and one simple seta; tarsus II with one finely spinose seta distally, one short peglike sensory seta distally, two simple setae and four finely pilose setae subterminally; tarsal segment terminates in a fringed empodium flanked by two small recurved claws. Coxa III with one lanceolate spinose seta and one simple seta; trochanter III with one lanceolate, spinose seta; femur III like femur II; genu III like genu I; tibia III like tibia II; tarsus III without short spinelike sensory seta, otherwise like tarsus II. Coxa IV bare; trochanter IV bare; femur IV with one subclavate spinose seta; genu IV bare; tibia IV like tibia II; tarsus IV without finely spinose seta distally, otherwise like tarsus III. Length of tarsus I, 102μ; length of tibia I, 71μ. Length of leg I, 190μ; length of leg IV, 175μ.

Deutonymph: (Plate VI, figures 27-29)—Length of body, 336μ; including rostrum, 462μ; width of body, 238μ. Palpus and rostrum broad; palpal femur broadly rounded on outer margin, with two dorsal rodlike spinose setae, one ventrolateral finely pilose seta located near outer apical margin and two simple ventral setae; no genual setae; tibia with one long finely pilose seta and two simple setae, the segment terminated by a long curved simple claw having a single tooth at basal fourth; tarsus small, knoblike, with one apical peglike seta on tubercle, two apical simple whiplike setae and two apical combs, the outer comb with eighteen teeth adorning basal two thirds of inner margin, teeth decreasing in size toward base, this comb stouter and longer than inner comb, the inner tarsal comb with forty-seven teeth distributed along its entire inner margin, teeth decreasing in size toward base; coxa with one ventral simple seta. Rostrum with dorsal shield broadly emarginate at anterior margin, forepart striate-punctate, rear part finely punctate; rostrum with two ventrolateral simple setae distally, two dorsolateral simple setae subapically; peritreme simple, segments elongate, two to three segments between spiracle and longitudinally directed member. Single pair of eyes. Anterior dorsal shield large, covering most of propodosoma, rounded anteriorly, widening posteriorly, with three pairs of long marginal subclavate spinose setae, located at anterior angles of shield near eyes, one pair of similar setae at posterior angles of shield, two pairs of spinose, subclavate setae located submesally on posterior half of shield; entire shield finely punctate. One pair of long dorsolateral spinose shoulder setae between legs II and III. Dorsum of hysterosoma with five horizontal rows of spinose setae; first row with four setae, each borne on a minute plate; second row with four setae, two borne on each of the two moderately large and widely separated dorsal plates; third row with four setae, each borne on a minute plate; fourth row with four setae; fifth row consisting of two setae situated terminally on opisthosoma; all dorsal hysterosomal plates are finely punctate with intervening integument finely striate. Venter of propodosoma with two pairs of submedian simple setae, one pair situated mesad from coxae I, the other pair posteromesad from coxae II. Venter of hysterosoma with three pairs of submedian simple setae one pair mesad from coxae IV, the other two pairs posteromesad from coxae IV; terminal anal opening flanked by four pairs of short stout setae. Coxa I with two simple setae; trochanter I with one spinose seta; femur I with two spinose setae; genu I with two spinose setae; tibia I with three spinose setae basally, one very long, one short spinose setae subapically, one very short, peglike, sensory seta situated subapically; tarsus I as illustrated. Coxa II with one simple seta; trochanter II like trochanter I; femur II with two spinose setae; genu II like genu I; tibia II with three spinose setae, one simple seta; tarsus II with one short peglike sensory seta, one lanceolate spinose seta, and one short simple seta located distally on segment; two long simple setae located subterminally, one short sensory peg and one long, pilose seta located at about mid-segment; tarsal segment terminates in a fringed empodium flanked by two small recurved claws. Coxa III with one spinose seta and one lanceolate simple seta; trochanter II with two spinose setae; femur III with two spinose setae; genu III like genu I; tibia III like tibia II; tarsus III without short peglike sensory seta, otherwise like tarsus II; pretarsal elements as on leg II. Coxa IV with two simple setae; trochanter IV with one spinose seta; femur IV with one spinose seta; genu IV like genu I; tibia IV like tibia II; tarsus IV like tarsus III; pretarsus as on leg II. Length of tarsus I, 110μ; length of tibia I, 80μ. Length of leg I, 453μ; length of leg IV, 414μ.

Holotype: Female, Lawrence, Kansas, August 24, 1951, D. T. Dailey, from litter in cattle barn.

Allotype: Male, same data as holotype.

Paratypes: Larva (morphotype), Lawrence, Kansas, August 2, 1951, D. T. Dailey, reared in laboratory culture; protonymph (morphotype), Lawrence, Kansas, August 26, 1951, D. T. Dailey, reared in laboratory culture; deutonymph (morphotype), same data as protonymph; fifty female and fourty-six male paratypes, all from Lawrence, Kansas.

Location of types: Holotype, allotype, morphotypes, forty-two female paratypes and thirty-eight male paratypes deposited in the Snow Entomological Museum, University of Kansas. Eight male and eight female paratypes deposited in the U. S. National Museum, Washington, D. C.

Type habitat: Most of the specimens of the type series were collected from straw litter taken on the ground in an abandoned cow barn in Lawrence, Kansas and removed from the litter by the berlese trap method or were reared in the laboratory from specimens collected in the field at the locality mentioned. Some specimens in the paratype series were collected from one year old, rotted hay taken from a field in Lawrence, Kansas and processed through a berlese trap. To date, this species is known only from specimens taken in Lawrence, Kansas.

This species is named to honor Dr. George F. Knowlton, who has contributed vast numbers of mite specimens to the Snow Entomological Museum collections and has in many other ways encouraged acarological studies at the University of Kansas.

Cheletophyes knowltoni was found to be entirely predaceous, feeding preponderantly on other species of mites. In only one instance, during the course of this study, was predation on an insect observed and this involved the feeding of a larva on an immature psoccid. Within the order Acarina this mite has been seen to feed on members of the families Parasitidae, Laelaptidae, Cheyletidae, Bdellidae, Acaridae, and Tydeidae. No attempt was made to feed upon mites of the family Cunaxidae nor on the members of the groups Oribatei and Uropodina, even when the cheyletid was in a state of semistarvation and these mites abundant. They were not observed to feed on *Cheyletus eruditus,* although found in close association with that species in stable litter. However, *C. eruditus* was often observed feeding on *Cheletophyes knowltoni. Cunaxa* sp. taken in great numbers in berlese funnels along with *C. knowltoni* seemed to prey almost exclusively on this cheyletid. All life stages of the cunaxid could be found feeding on all stages of the cheyletid. The cunaxid usually attacked the mite from the rear, being able to outmaneuver the cheyletid by reason of their greater agility. Cunaxid larvae have been observed overpowering large cheyletid nymphs.

The mite was cannibalistic if the opportunity presented itself, feeding on smaller or weakened members of its own species. This behavior was usually seen in mass rearing pens when the acarids used for food became scarce. Adults of this species seemed to ignore extremely small prey such as acarid larvae and would die, apparently from starvation, in a rearing pen containing a quantity of the acarid larvae. If an adult acarid was introduced into this pen, the *Cheletophyes* would immediately feed upon it.

The immature stages were not seen feeding upon mite eggs of any species. However, one male kept in isolation with a female was observed to feed upon her eggs when there was a dearth of acarids for food.

This species did not require a pit or hiding place in which to lay in ambush as did *C. eruditus.* It would run actively about the rearing pen searching for food or, at times, lie flat on the substrate with legs and palps widespread until some victim brushed against legs I. The mite would then spring forward and seize its prey by a leg with the strong palps. The chelicerae would be inserted into the struggling victim's leg and, after about thirty seconds the victim would cease to offer any resistance, its legs would curl downward and all body movements would cease. During the period that the venom or toxic saliva was taking effect, the predator would be tugging and lifting at its prey. When the prey offered no more resistance, it would, if not too large, be lifted from the substrate and carried about while its body contents were drained. The venom or toxic saliva seemed to have little or no effect on other mites of its own species for, in instances of a cannibalistic attack, the victim would attempt to escape for some time and if released before too great a quantity of its body fluids were removed, seemed to recover completely.

C. knowltoni actively avoided bright lights and would congregate in the darker corners of the rearing pen when under illuminated microscope observation. The mite has one pair of eyes and seems to be able to distinguish movement, turning actively away from a dissecting needle moved in front of it.

The long front legs are not used in walking but seem to be primarily tactile appendages, being waved constantly on and about every object the mite was investigating. In attacking prey, once the prey was close enough to touch with the palps, the front legs were held laterally and rearward, apparently an attitude adopted to protect these appendages. This pose was maintained after the prey was overcome and was being carried or dragged about.

The mite usually remained on the side rather than on the bottom of the rearing pen. The molting form was usually found in this section of the rearing pen, affixed to the substrate with no attempt at concealment even when such concealment was provided by pits or bits of foreign material.

There was a period of varying duration before molting in which the mite would take no food, although its movements were quite active. The mite was not observed actually assuming the molting position. In this position the mite was prone on the substrate, with legs I and II stretched forward at full length. The remaining legs were extended to the rear at full length. This was a very typical position and was only assumed at the time of molting.

Behavior of adults. Observations of adult activities were made repeatedly and on large numbers of individuals. Typical behavior patterns are noted in the following. The male was observed guarding a molting deutonymph twelve hours before its emergence. The male would move rapidly around and around the molting form, tapping and stroking it with the tactile front legs. At the approach of other mites, the male would stand over the quiescent form and stab at the intruders with his palps, eventually driving them away by making short runs at them pinching vigorously with the palps. He would never move far from the deutonymph but immediately return and commence stroking and tapping it once more with legs I.

Upon emergence of the female, the male would run rapidly around her, tapping here and there over her body. The female would raise her front legs over her body and remain quiet. Eventually, the male would approach the female and repeatedly pinch first one and then the other of her palps. The female would remain quiet except for a slight movement of legs I held over her body. Receiving no rebuff, the male would seize one female palp in both of his and lead the female forward, sideways and backward for some time, moving very rapidly in this strange sort of dance. Then the male would half lift the female and slide beneath her, turning her in a half circle as he did so, so that she was above him, both mites facing in the same direction with the female legs placed indiscriminately on the dorsum of the male and on the substrate. Legs I of the female would still be held upward and to the side.

Swift and repeated copulation would ensue, the venter of the female bending downward to make contact with the phallus of the male. Contact was rapid and frequent. The female would then move away for some distance (about one centimeter) and remain quiet. The male would search for her and, upon locating her, the entire courtship and mating would be repeated. A total of ten courtships and subsequent matings were observed in a period of about ten minutes. There was no attempt on the part of the female to harm the male in any way after the mating activity was completed. In fact, the two mites shared the same rearing pen for ten days afterward without harming one another.

About forty-eight hours after copulation, egg deposition began. The eggs were laid singly, always in a depression or cavity of some type, if available, and were covered by strands of silk. The egg itself was not touched by the strands which were affixed at the mouth of the depression to form a loose network. The silk emerged from the apex of the rostrum in a continuous strand. The female walked sideways across the depression, but always turned and moved backward just before anchoring the strand of webbing. This was done by pressing the apex of the rostrum against the substrate. The angle formed by two connectively-anchored strands of silk was variable and did not seem to follow any set pattern. After a few strands had been deposited, the female would walk on them while crossing the pit. When a number of strands of silk had been anchored close to and on the edge of the pit, the female would move away from the edge an increasingly greater distance, apparently to find fresh locations on which to anchor the silk. During the deposition of the webbing, legs I were held quiescent, upward and backward over the body. The palps were not observed to have any function in depositing the silk. The entire meshwork of silk was formed in about five minutes. Up to sixteen eggs from a single female were obtained in the laboratory, the eggs being laid over a period of nine days. The female usually died in one to two days after her total number of eggs were laid.

Females kept in isolation during the deutonymphal stage would, upon emerging as adults, start oviposition within two to twelve days. A maximum of twelve eggs was recovered from an unfertilized female. The eggs were viable, the larvae emerging from two to four days after the eggs were laid.

During the period of egg-laying the female ate voraciously, feeding on five to six acarid females every twenty-four hours and draining the bodies of each victim completely.

The male, after mating, was quite active for a period of about twelve days. It was an active feeder, consuming as many as five acarid females or nymphs within a twenty-four hour period. In one instance a male was observed feeding on an egg of its own species, feeding through the web which covered the eggs.

Egg: The eggs when first laid are ovoid, semitransluscent, smooth and shiny. The embryo head developed at the slightly broader end, the appendages being clearly visible before hatching. In size, the eggs averaged 137μ in length and 103μ in width. The egg hatched in two to three days at 80°-85° F., the average being two and one-fourth days. The egg shells were very conspicuous after hatching had taken place, as they reflected a brilliant blue light as has been reported by M'Intire (1869) for an unidentified species of cheyletid.

Larva: For some time after emergence from the egg, the larva remained under the strands of silk which had covered the egg. To get from under this silk, the larva would carefully work two strands apart and force the body through the opening thus made.

The larva usually refused food the first day of its life, but would make vigorous attempts to feed on any food presented the following day. Female acarids, much larger than the larva, were occasionally attacked, the larva seizing a leg with its palps and attempting to insert the chelicerae in the acarid's leg. These attempts were usually unsuccessful, the larva being knocked off against the substrate during the acarid's efforts to escape. However, larvae have been observed to overpower acarid nymphs much larger than themselves. It appeared that if they were able to insert the chelicerae and remain attached for a period of time, the toxic saliva or venom which they seem to produce apparently had a quieting effect on the acarid, eventually producing a type of stupor during which the cheyletid could feed without interference. Continued success in rearing larval *C. knowltoni* was assured when they were fed a diet of acarid larvae exclusively.

In two instances, recently hatched larvae which were still under the protective web were killed by being exposed suddenly to a strong microscope light. Whether it was the light or the attendant heat is unknown. The larvae, when struck by the light, would stiffen and expand all legs and mouthparts. Aside from some flexing of the palps for a short interval following such exposure, there was no more movement. The larvae, in each case, were at once returned to the rearing pen and the relative humidity of the rearing pen was increased. Such larvae did not recover.

For a period of time before molting, the larva took no food. The larva was not actually observed assuming the molting position though this characteristic stance was taken before ecdysis. The duration of the larval stadium was from two to seven days at 80-85° F., averaging four days.

Protonymph: The protonymph emerged after a twenty-four to forty-eight hour molting period. In attempting to escape from the larval skin, the protonymph would pull backward and upward with the forepart of the body, stretching the larval skin in the vicinity of legs II. After some minutes of this stretching, a transverse split would appear in the dorsum of the larval skin between legs II and III. The mite backed from the forepart of the larval skin, freeing legs I and II along with the gnathosoma. After a pause of a few seconds duration, the mite stepped out of the rear portion of the larval skin which often remained attached to the dorsum of the protonymph for ten minutes or more before dropping off. The actual molting process lasted about twenty-five minutes.

Legs IV of the protonymph were used for walking as soon as the mite emerged and were not held from the substrate for a time as was the case in newly emerged protonymphs of *Cheyletus eruditus*.

The protonymphs occasionally attempted to feed soon after emergence, but the palps did not appear strong enough to hold the prey. The protonymph was not observed feeding successfully until eight to twelve hours after emergence, when it would attack mites much larger than itself if they were slow-moving. In the laboratory the protonymph was fed acarid nymphs.

The protonymphal stadium endured from three to seven days at 80°-85° F., averaging four days, the nymph usually molting on the side of the rearing pen. As in the larval stage, the protonymph refused food for a short period before molting.

Deutonymph: The deutonymph emerged after approximately a twenty-four hour molting period and would usually refuse food for eight to twelve hours. The nymph was fed on acarid adults, having no trouble in subduing them with its toxic saliva or venom. This stage would refuse food for a period before molting and would molt on the side of the rearing pen. The deutonymphal stadium lasted from four to seven days at 80°-85° F., averaging five days.

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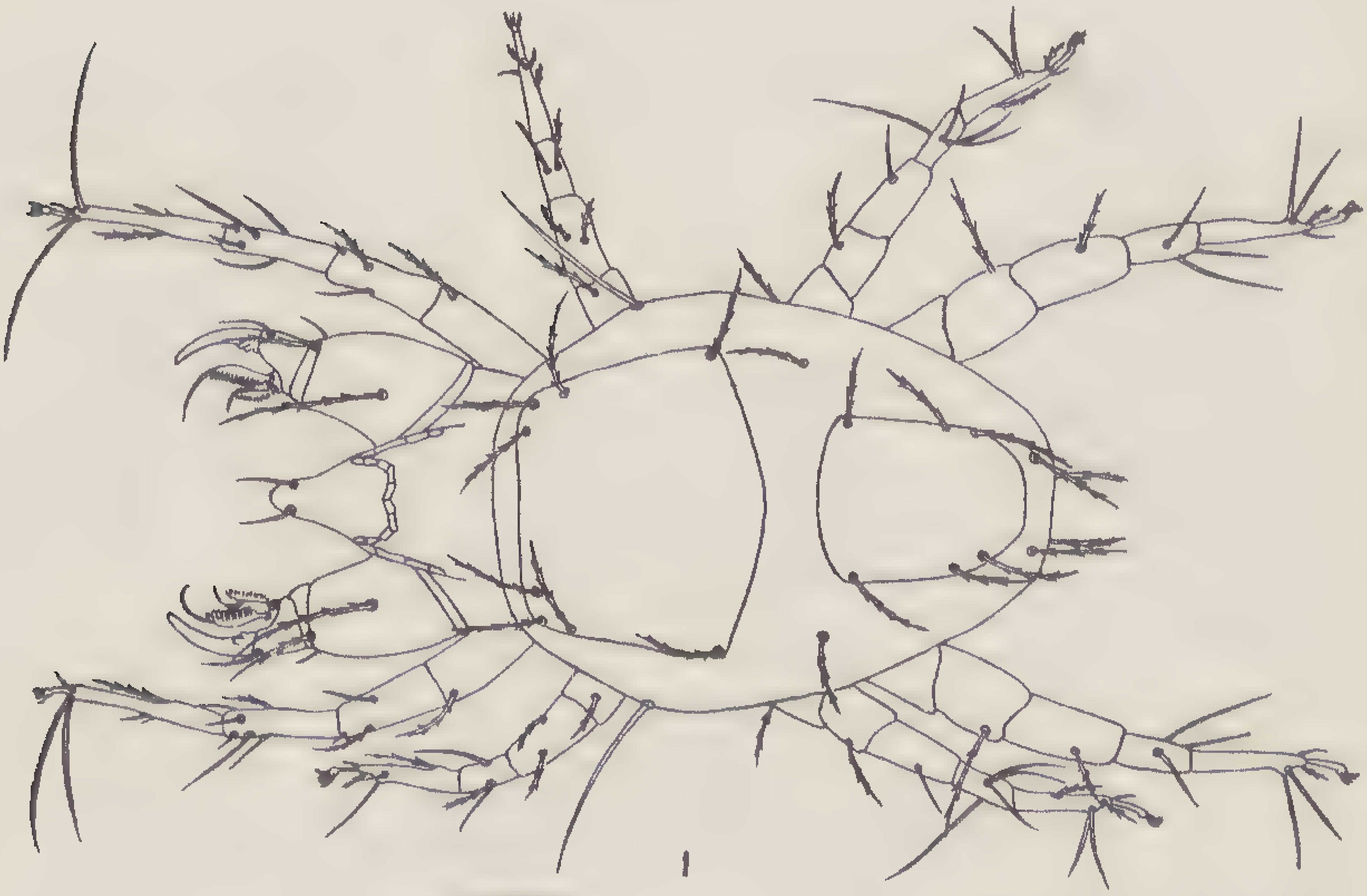
PLATE 1

Cheyletus eruditus (Schrank)

FIG. 1. Dorsal view of female.
FIG. 2. Ventral view of female.
FIG. 3. Portion of right palpus of female.
FIG. 4. Portion of leg I of female.

PLATE I



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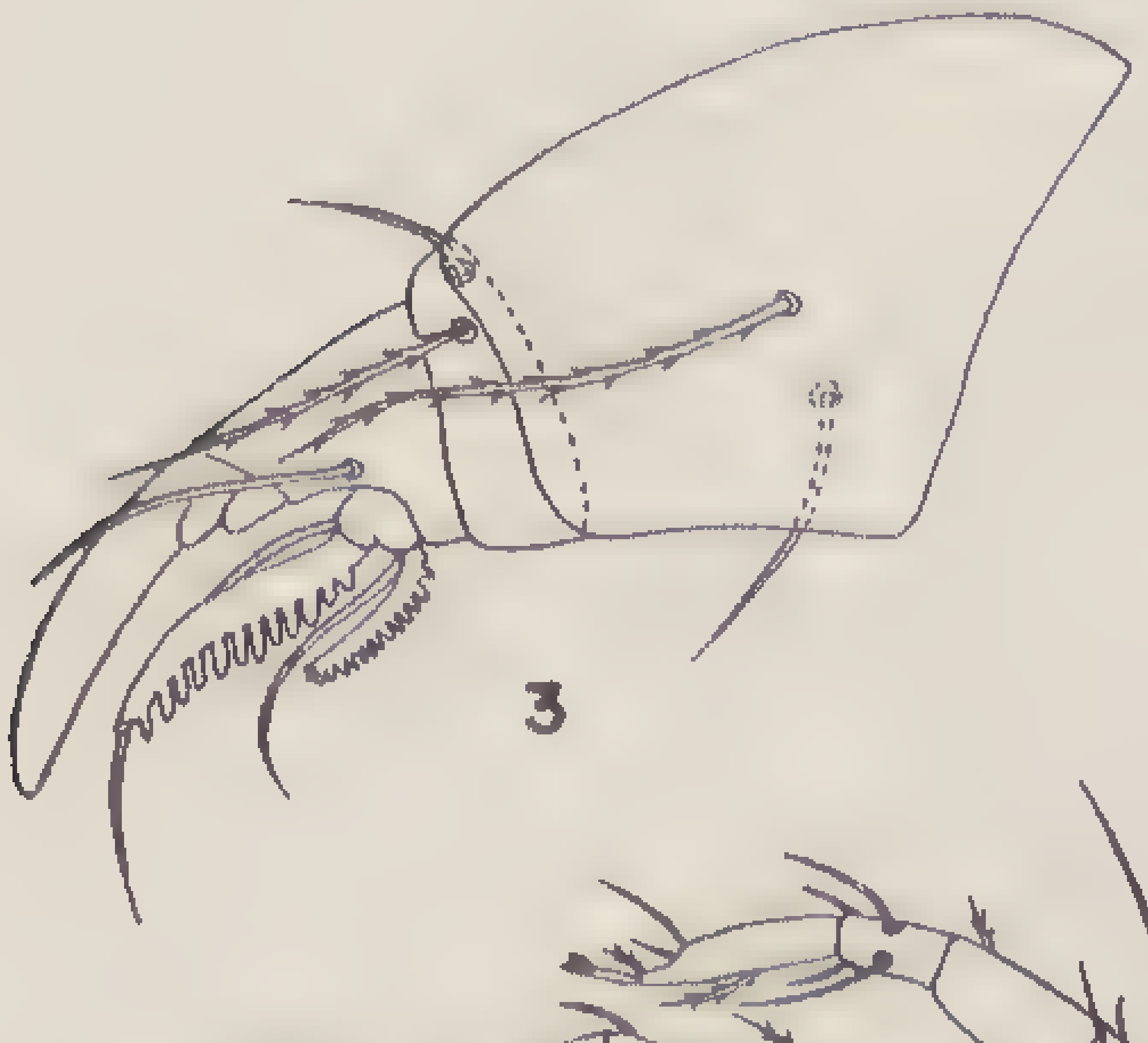

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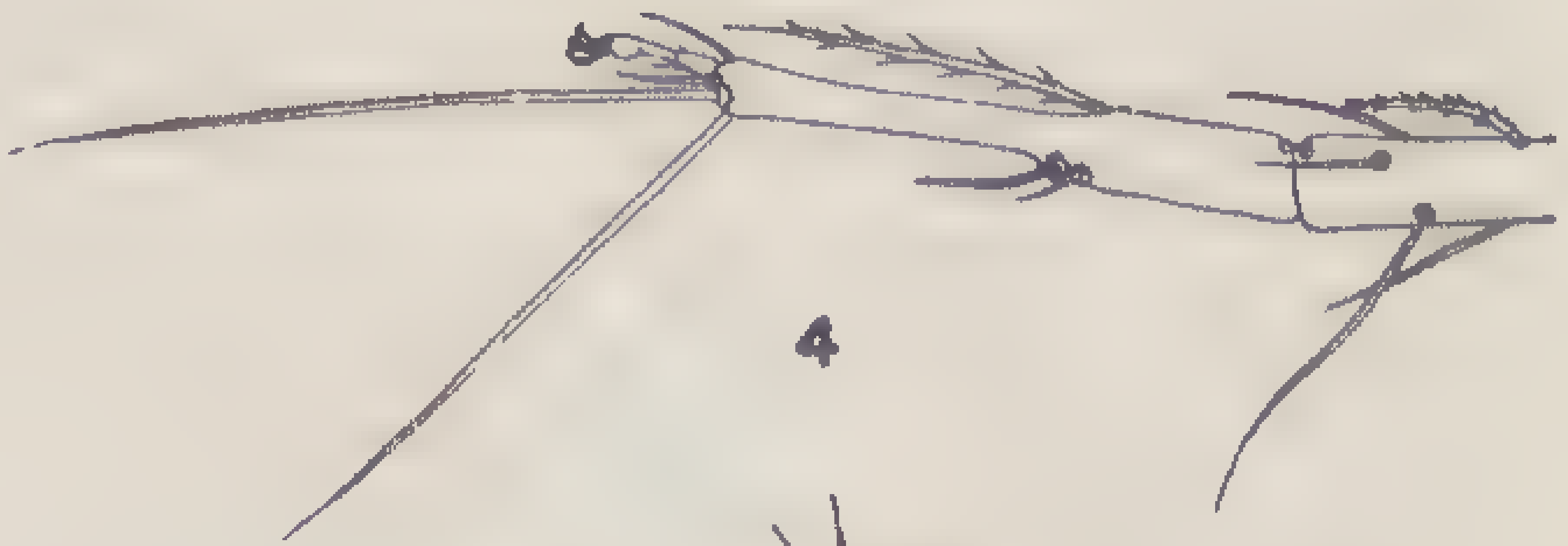

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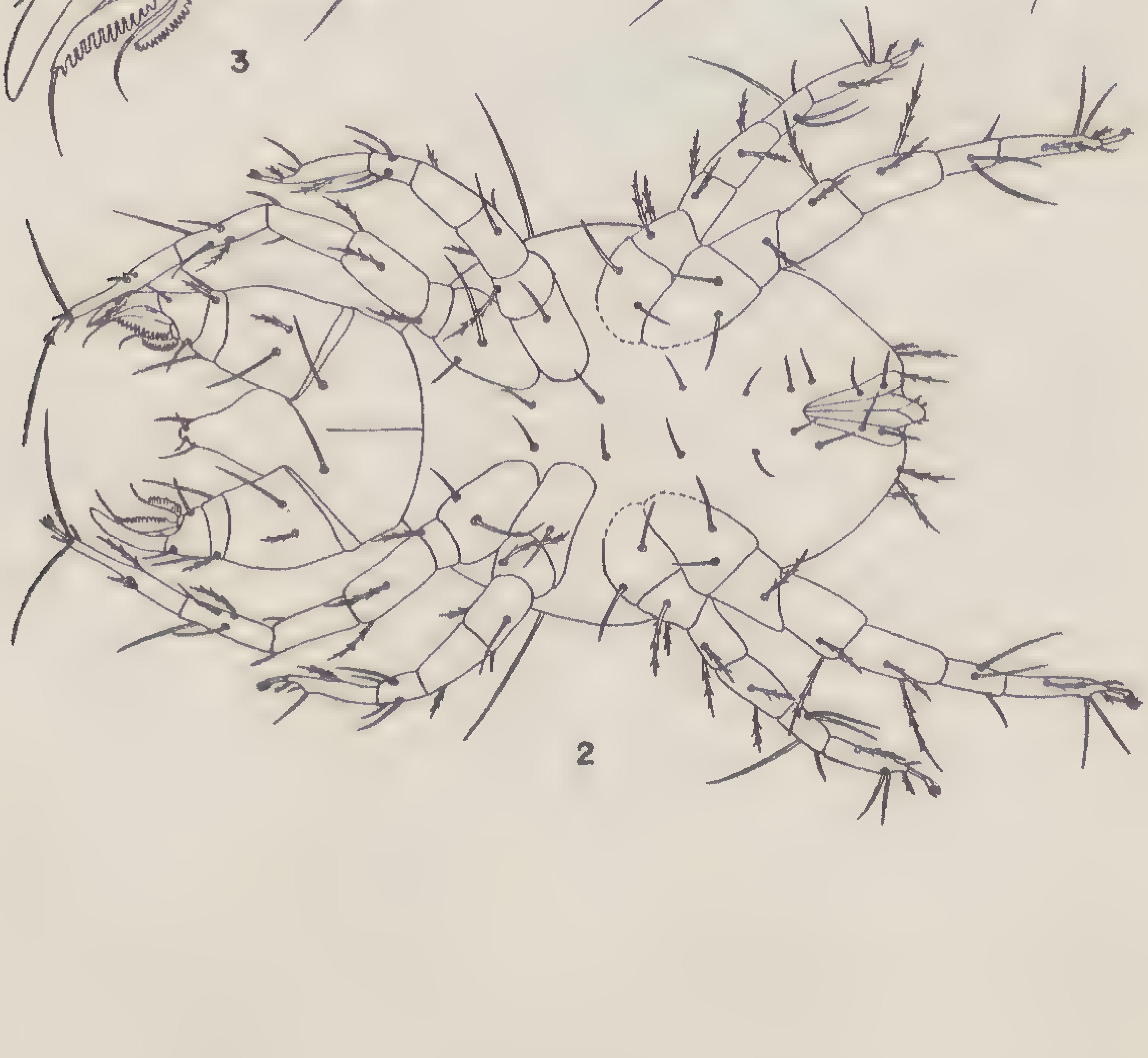

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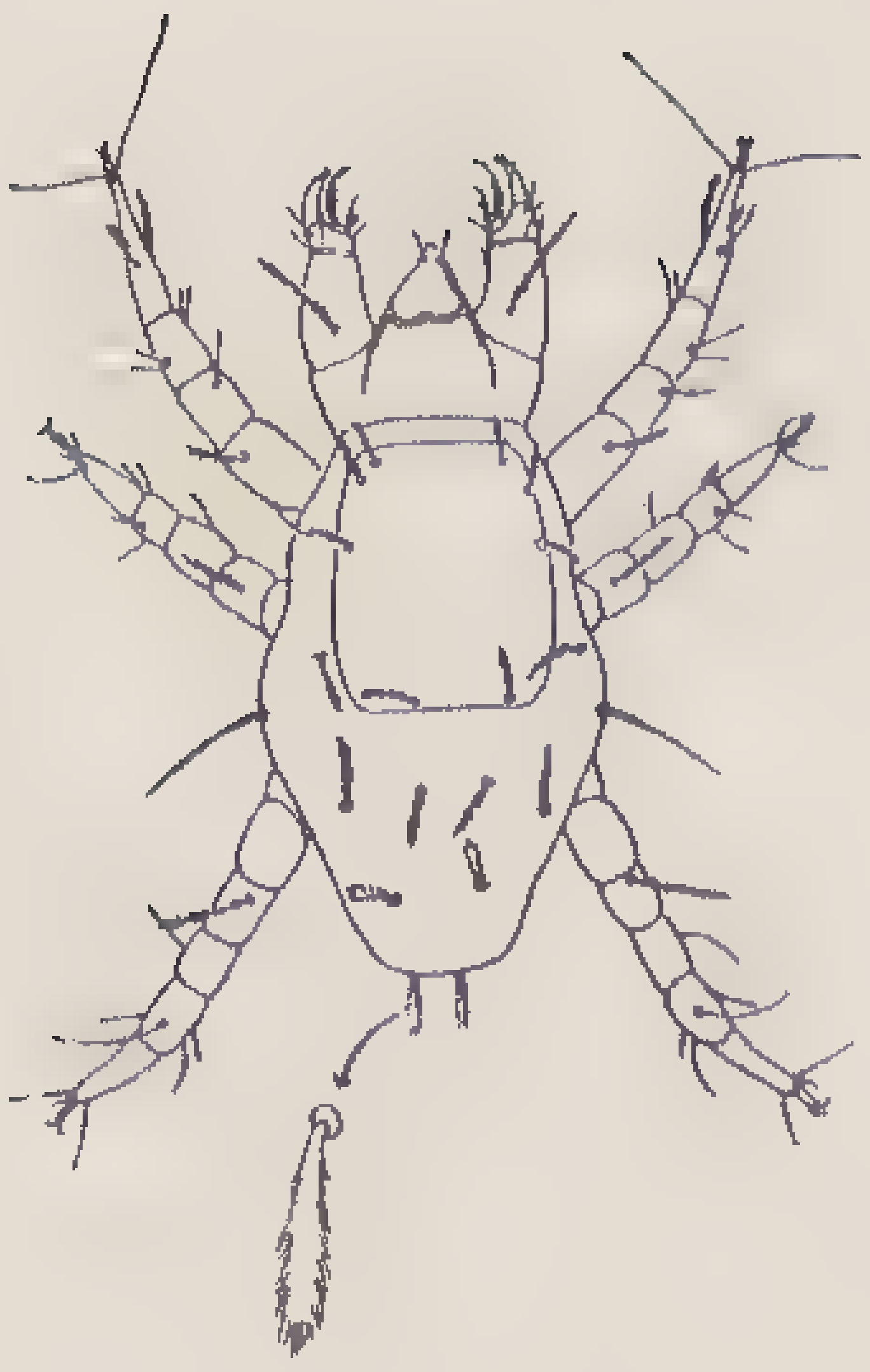
PLATE II

Cheyletus eruditus (Schrank)

FIG. 5. Dorsal view of larva.
FIG. 6. Portion of right palpus of larva.
FIG. 7. Portion of leg I of larva.
FIG. 8. Portion of right palpus of protonymph.
FIG. 9. Portion of leg I of protonymph.
FIG. 10. Dorsal view of protonymph.
FIG. 11. Portion of left palpus of deutonymph.
FIG. 12. Dorsal view of deutonymph.
FIG. 13. Portion of leg I of deutonymph.

PLATE II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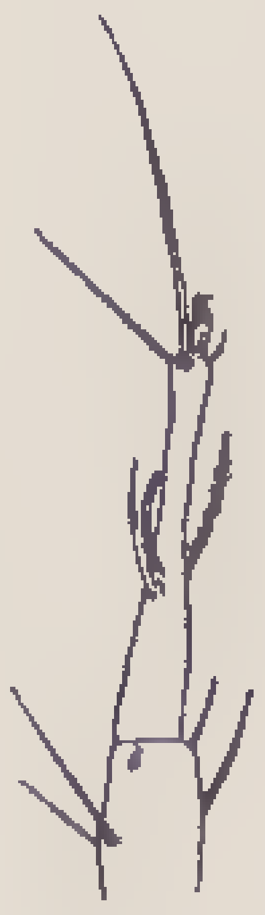
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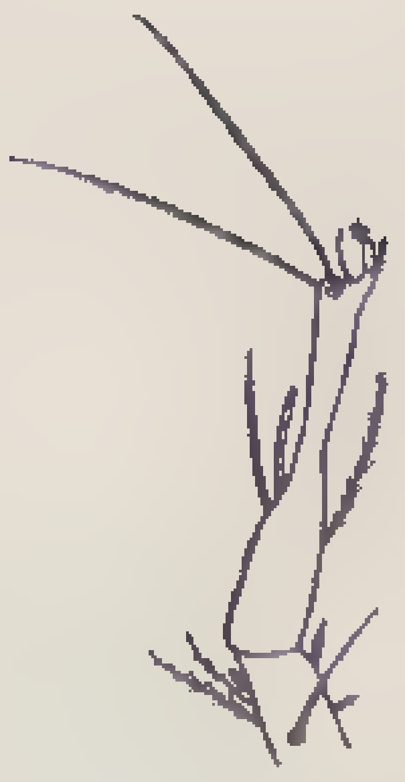
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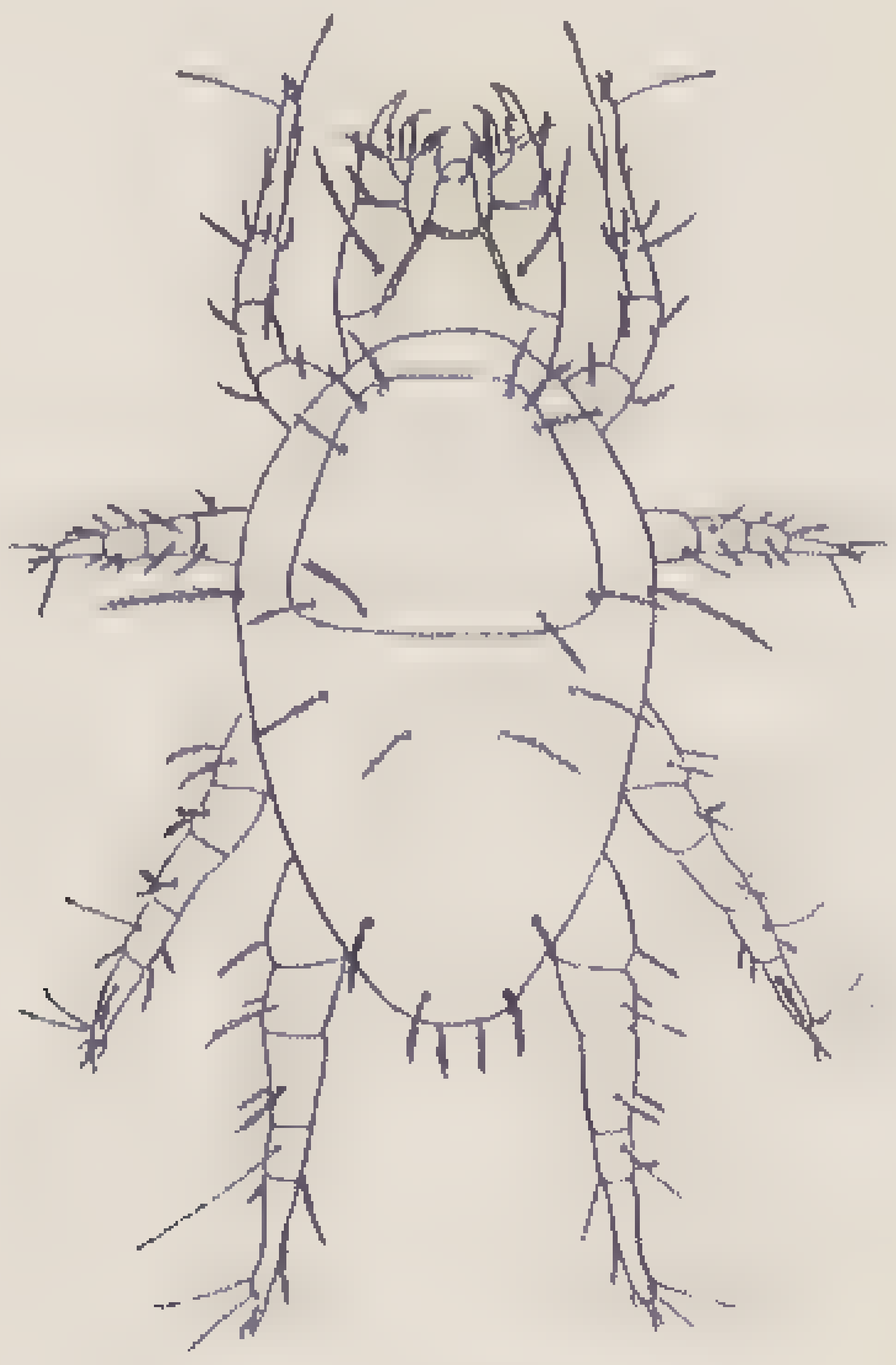
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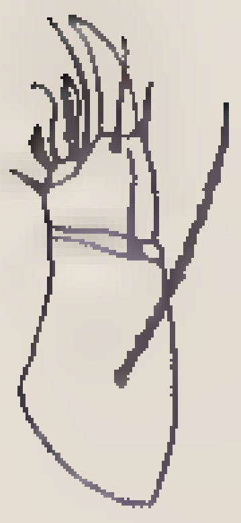
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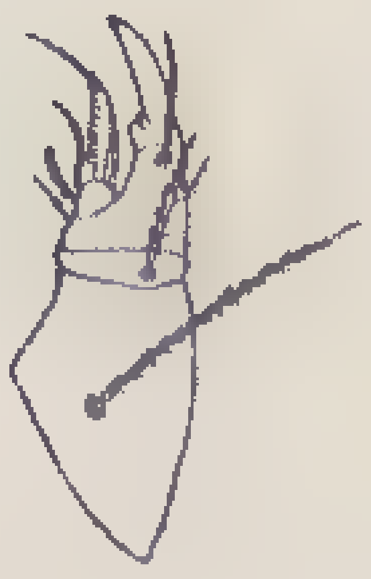
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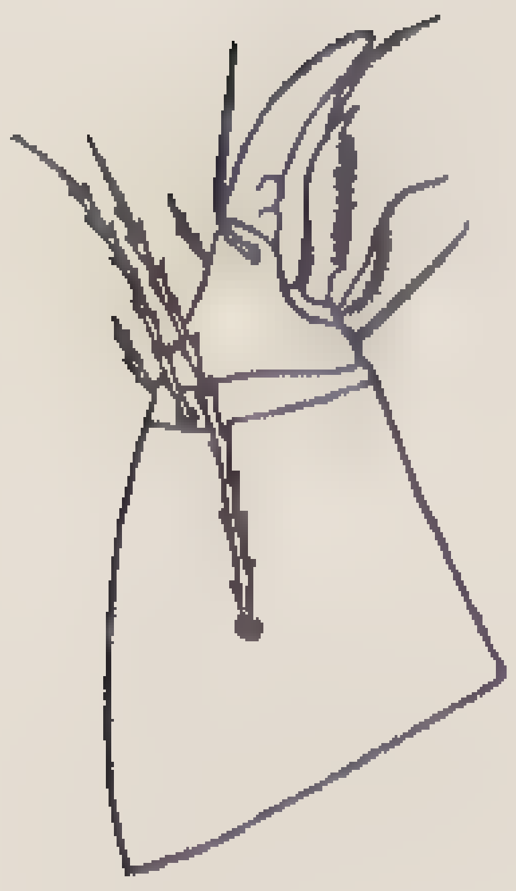
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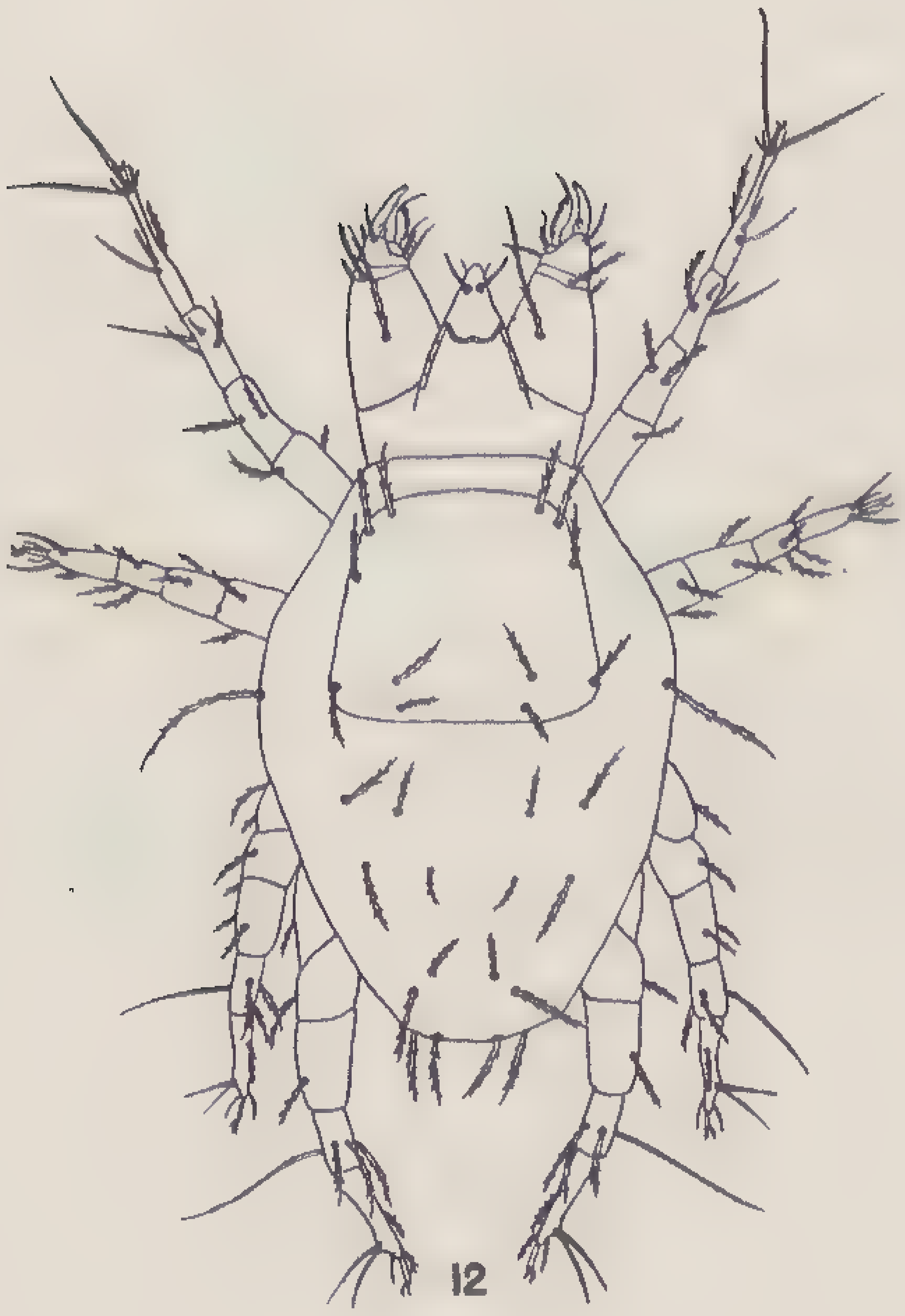
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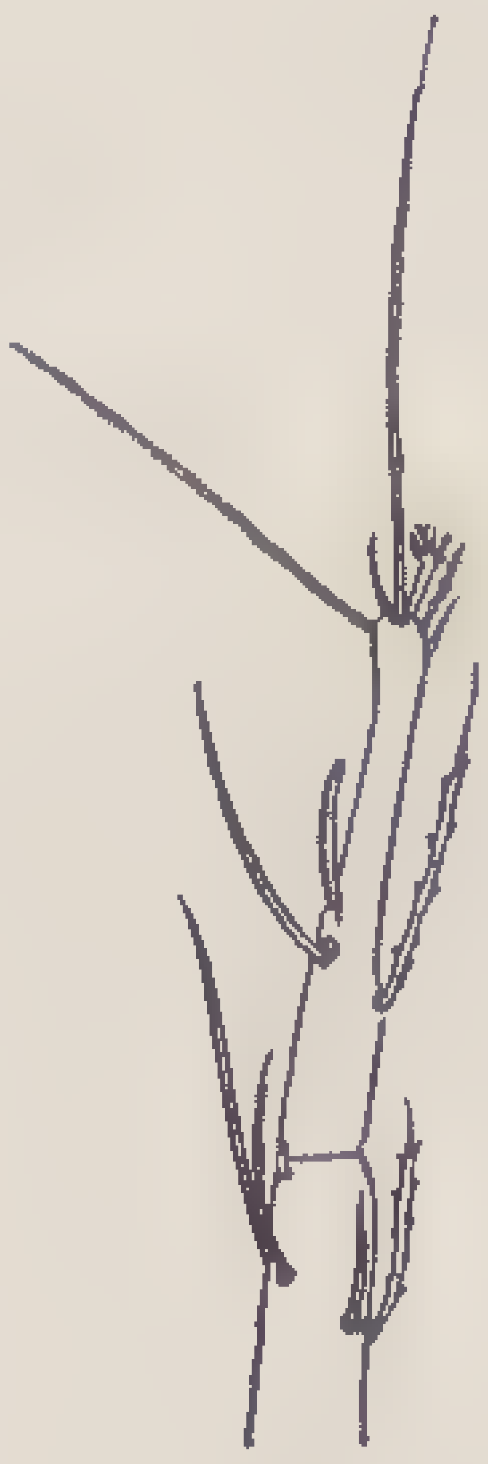
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PLATE III

Cheletophyes knowltoni, new species

FIG. 14. Portion of leg I of female.
FIG. 15. Portion of right palpus of female.
FIG. 16. Dorsal view of female.

PLATE III

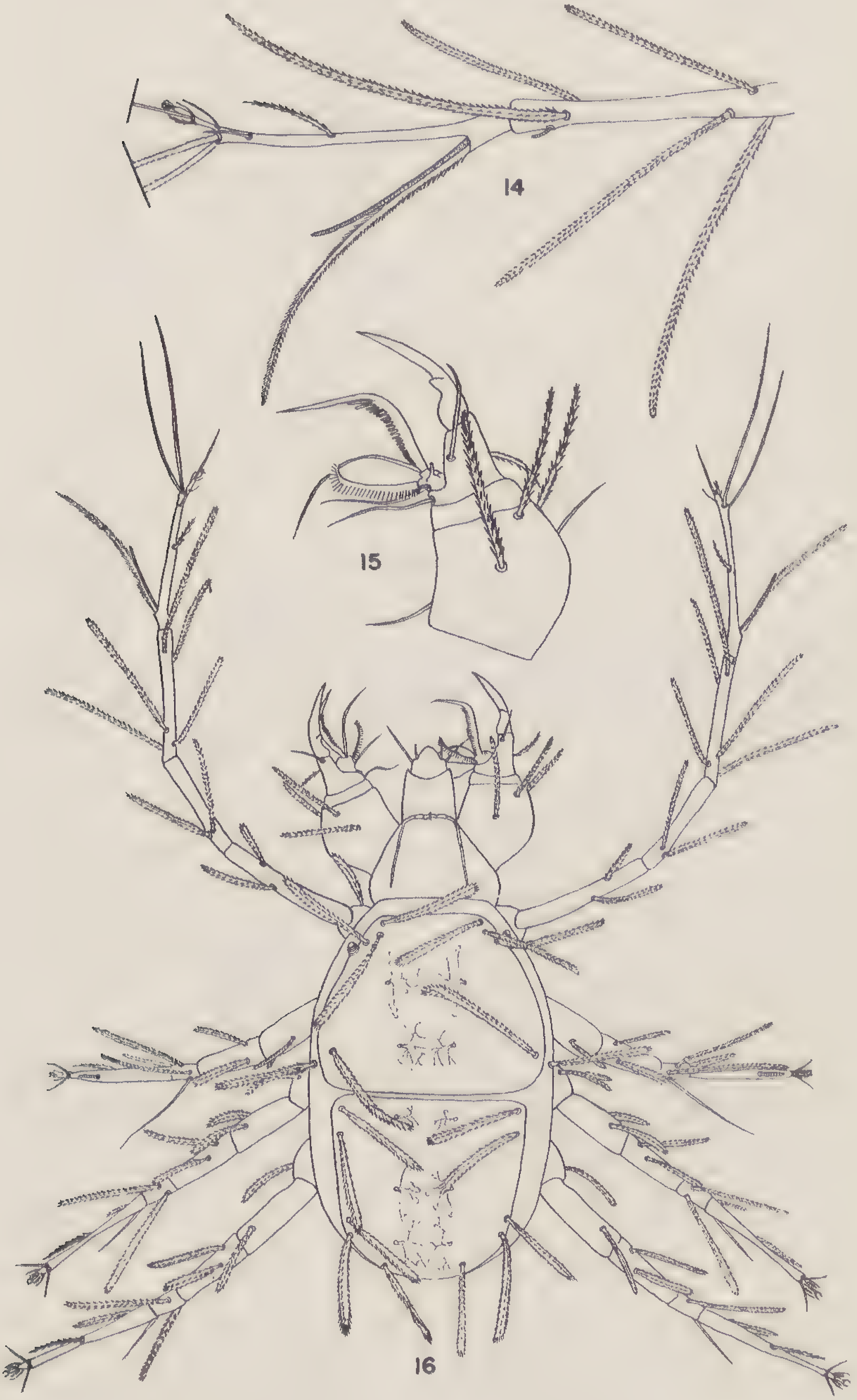
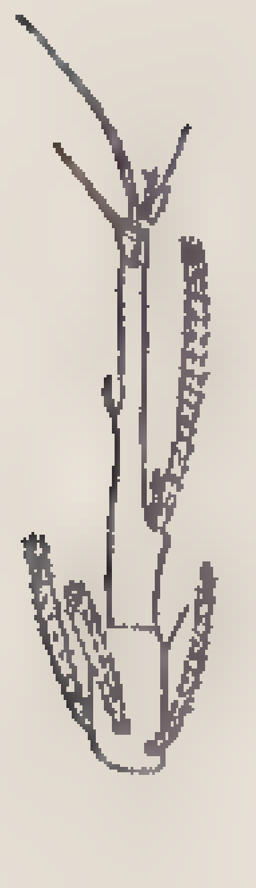


PLATE IV

Cheletophyes knowltoni, new species

FIG. 17. Portion of leg I of larva.
FIG. 18. Dorsal view of larva.
FIG. 19. Portion of right palpus of larva.
FIG. 20. Ventral view of female.

PLATE IV



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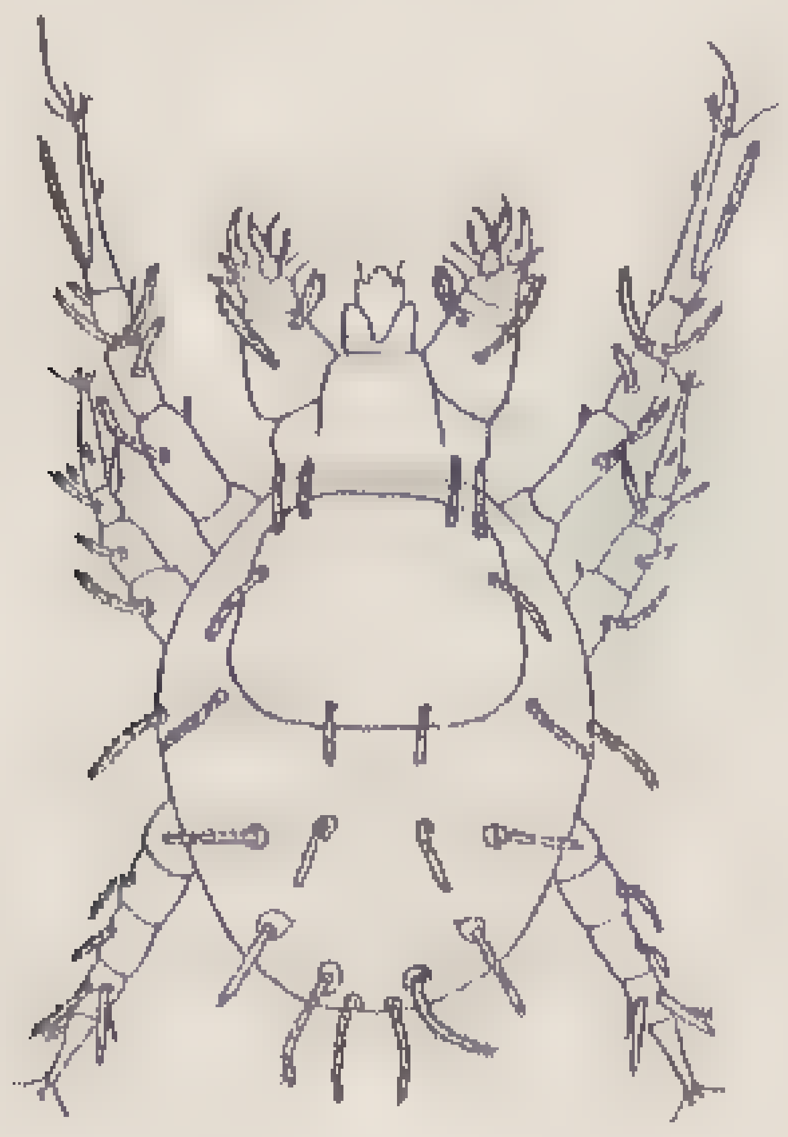

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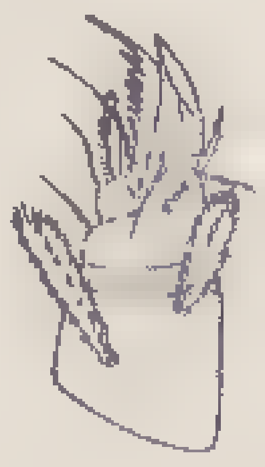

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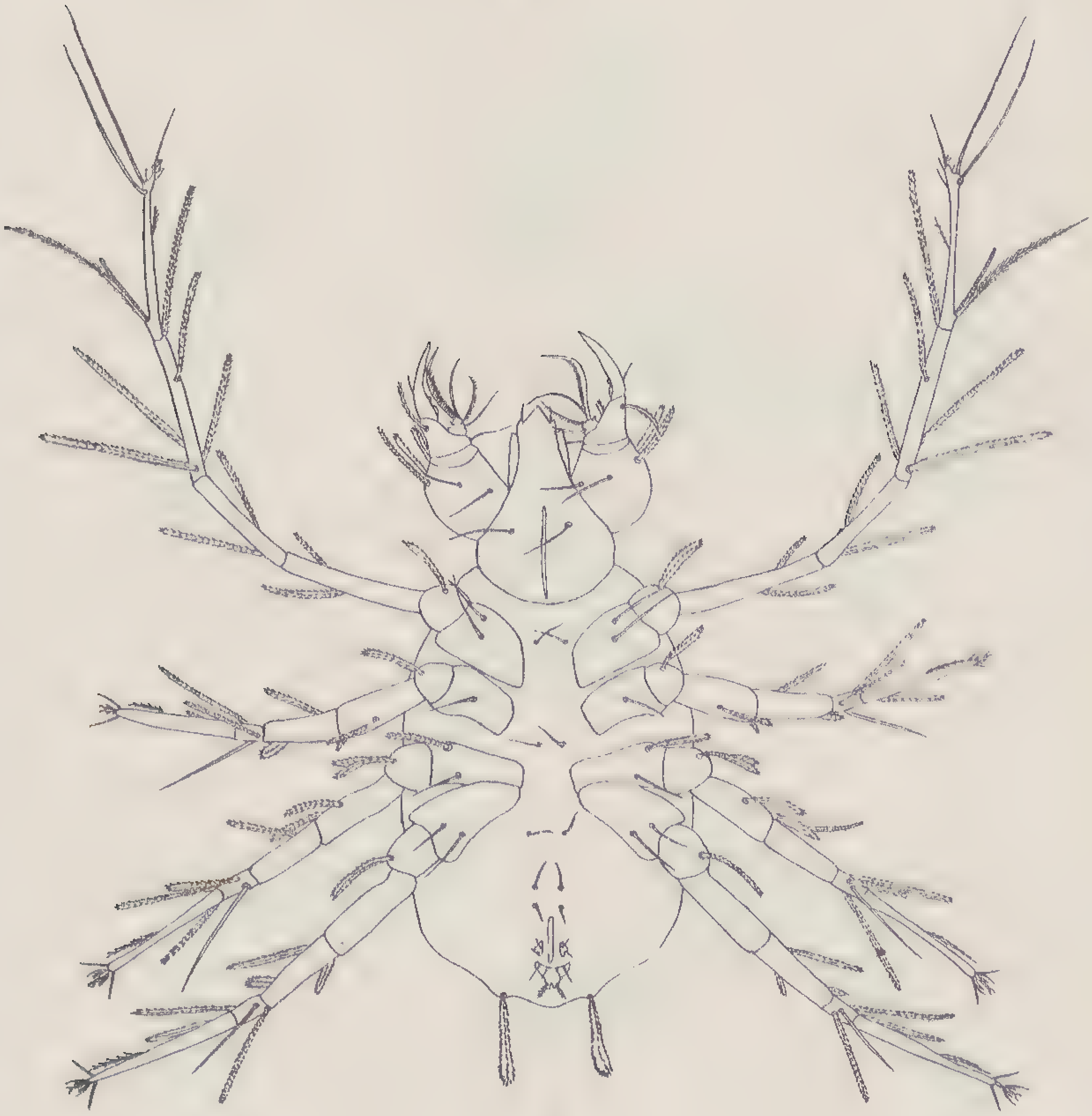

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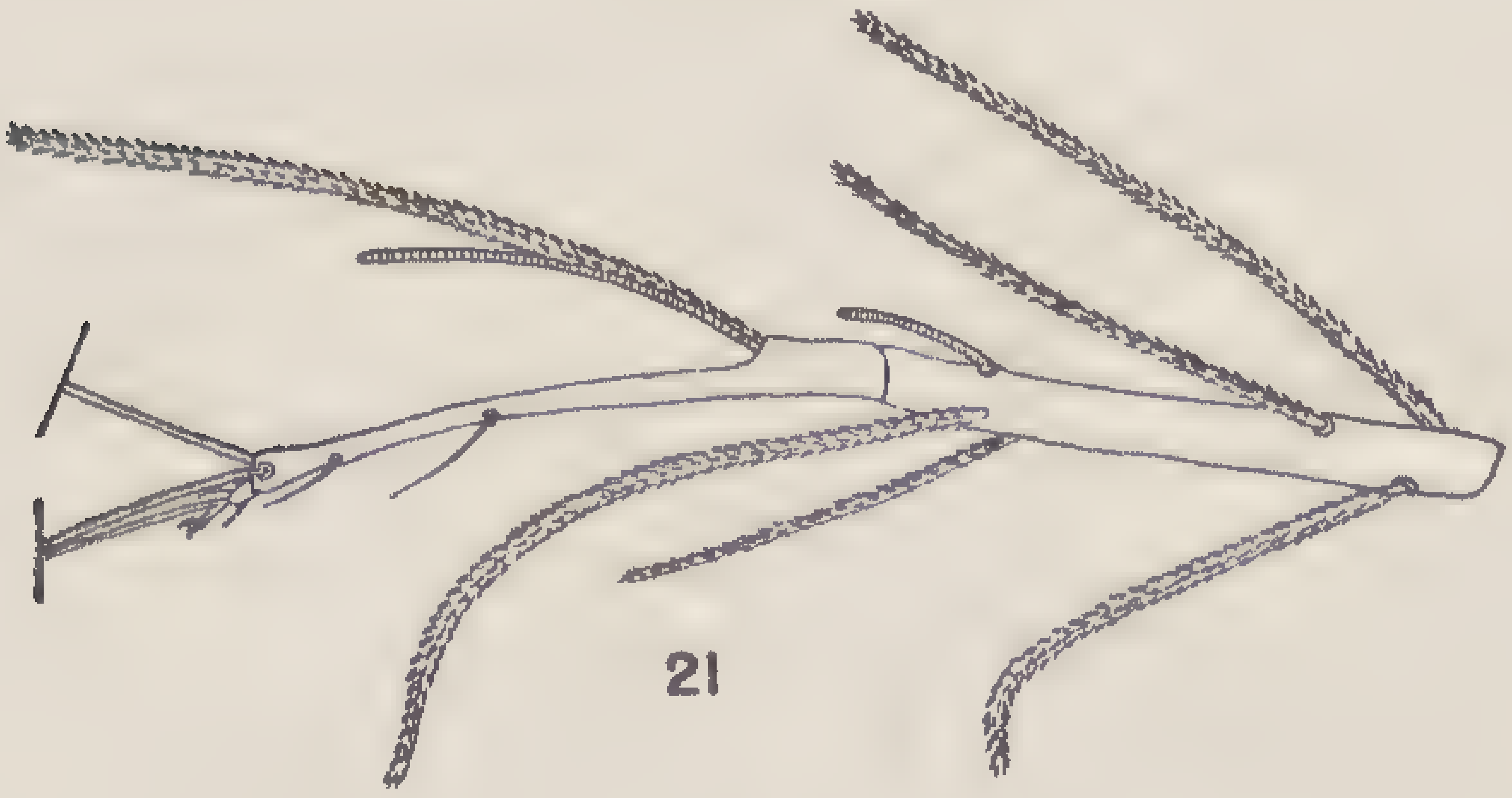
PLATE V

Cheletophyes knowltoni, new species

FIG. 21. Portion of leg I of male.
FIG. 22. Portion of left palpus of male.
FIG. 23. Dorsal view of male.

PLATE V



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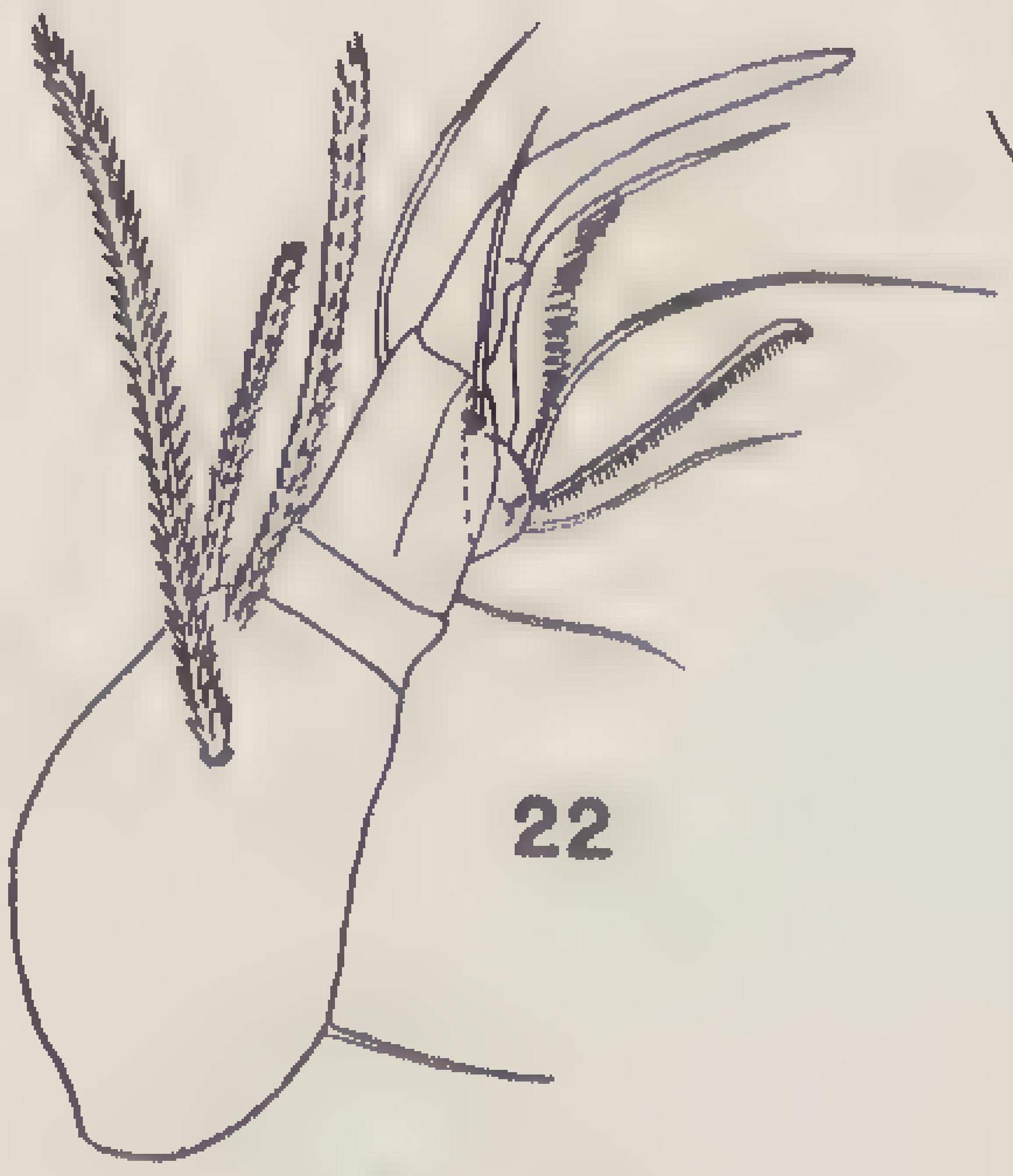

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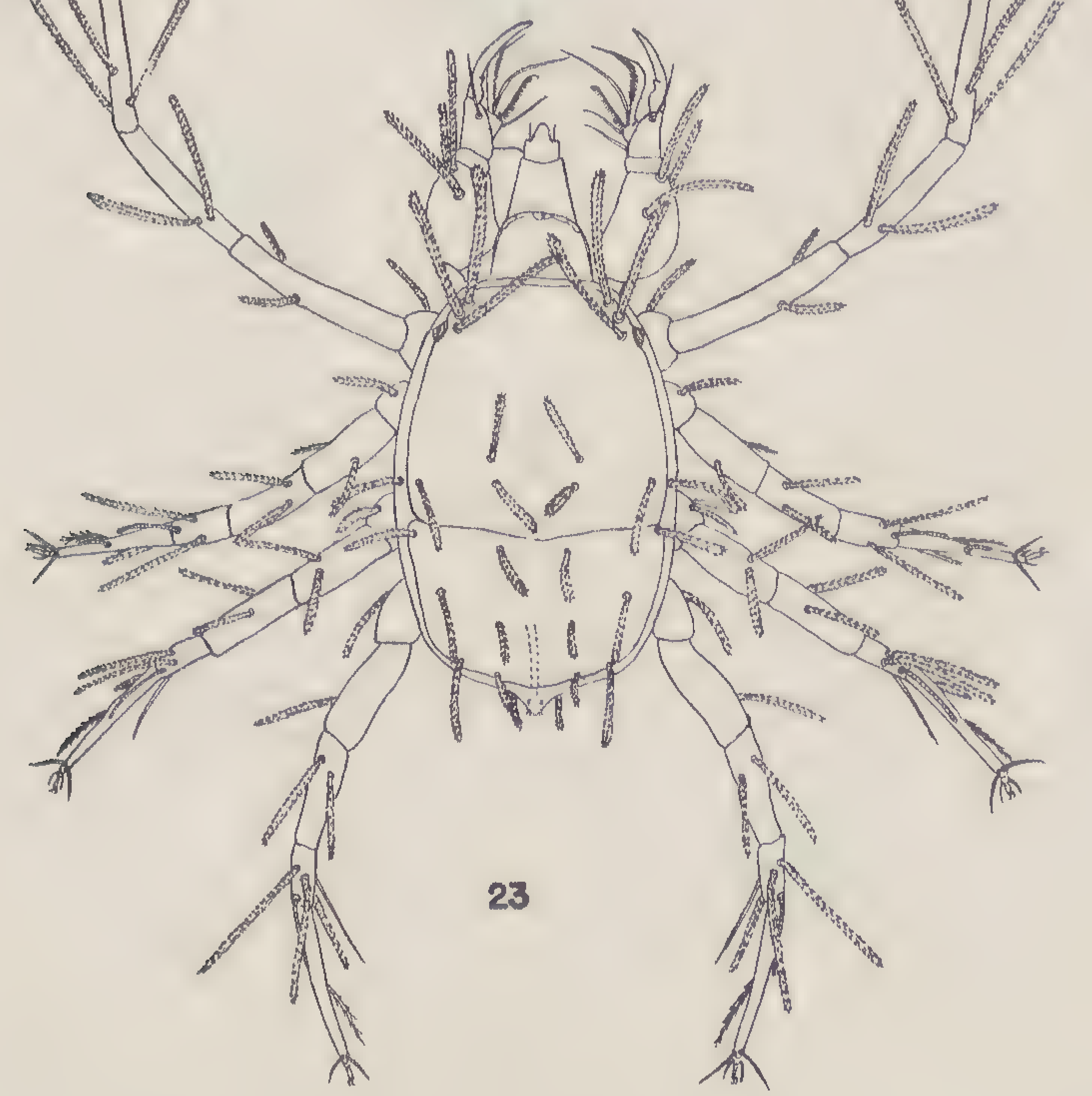

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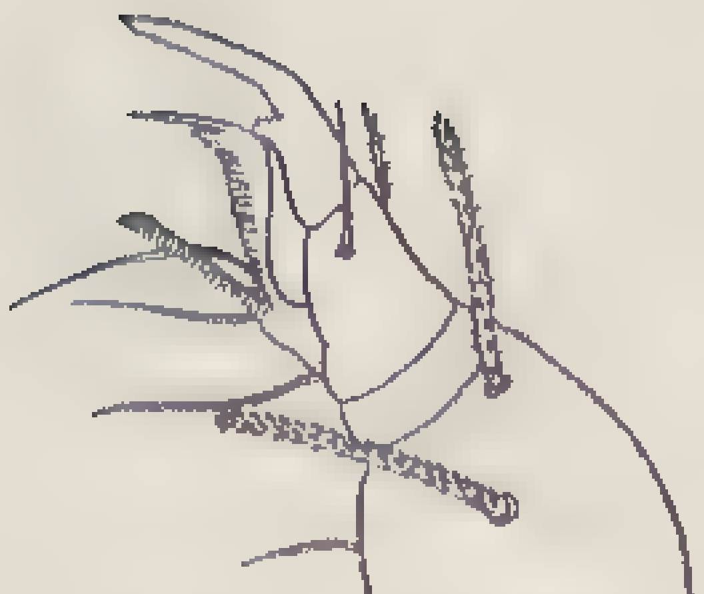
PLATE VI

Cheletophyes knowltoni, new species

FIG. 24. Portion of right palpus of protonymph.
FIG. 25. Portion of leg I of protonymph.
FIG. 26. Dorsal view of protonymph.
FIG. 27. Dorsal view of deutonymph.
FIG. 28. Portion of right palpus of deutonymph.
FIG. 29. Portion of leg I of deutonymph.

PLATE VI



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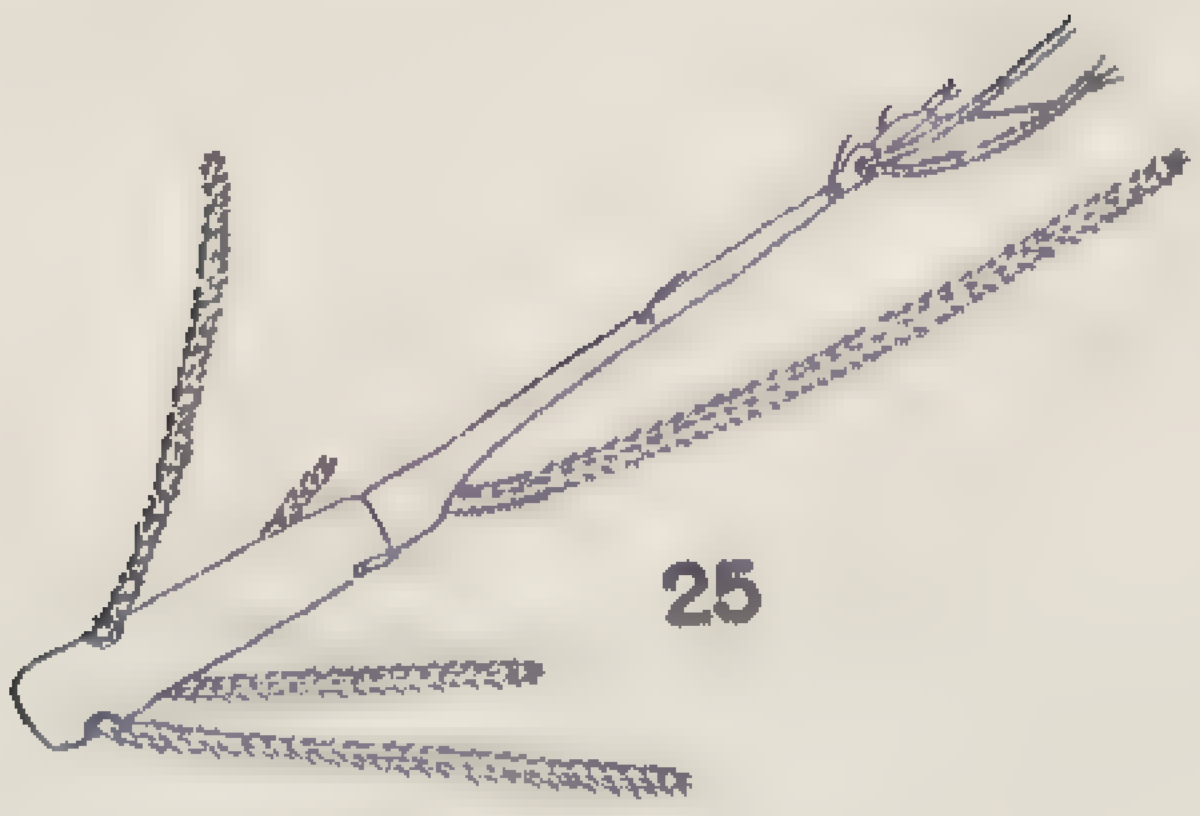

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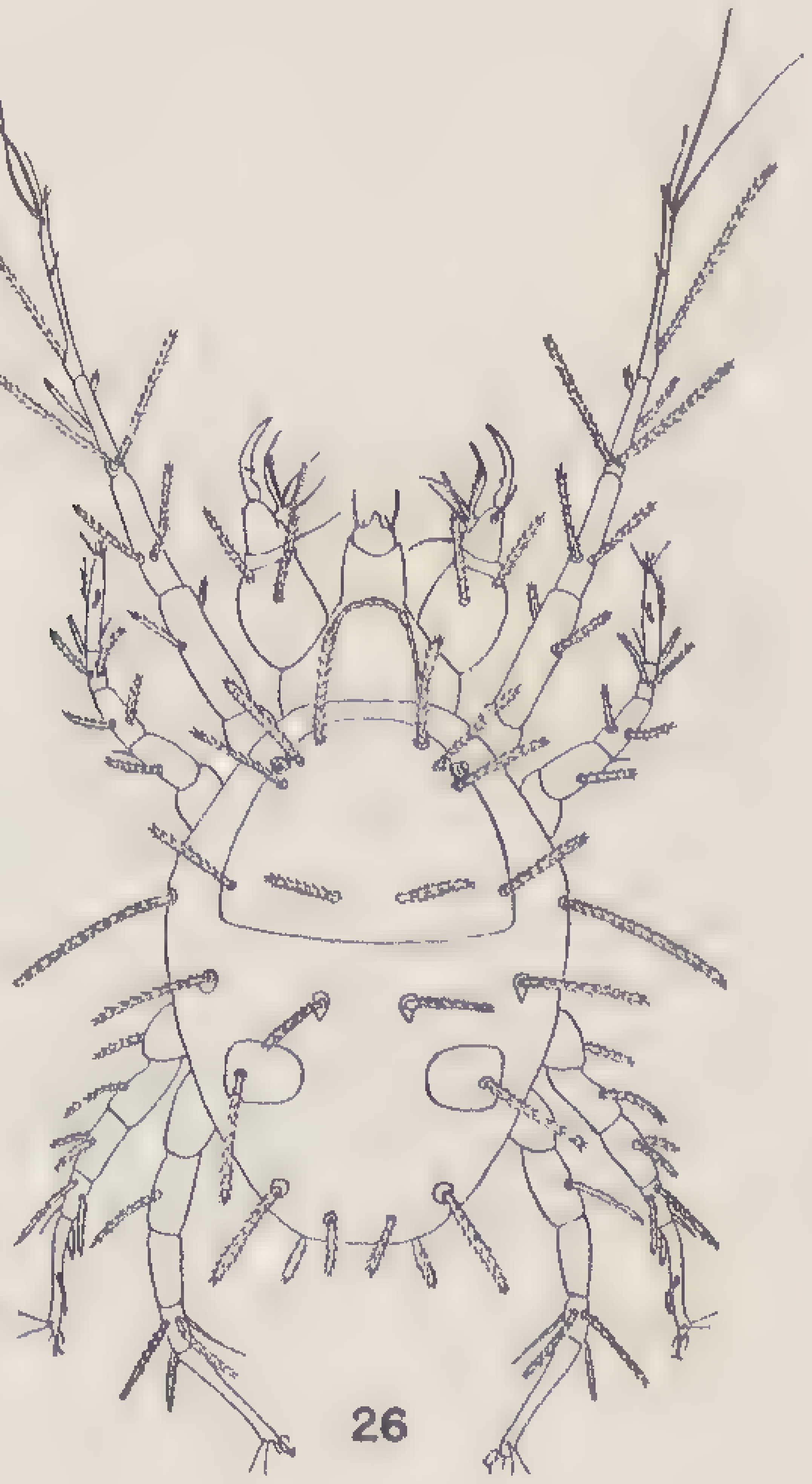

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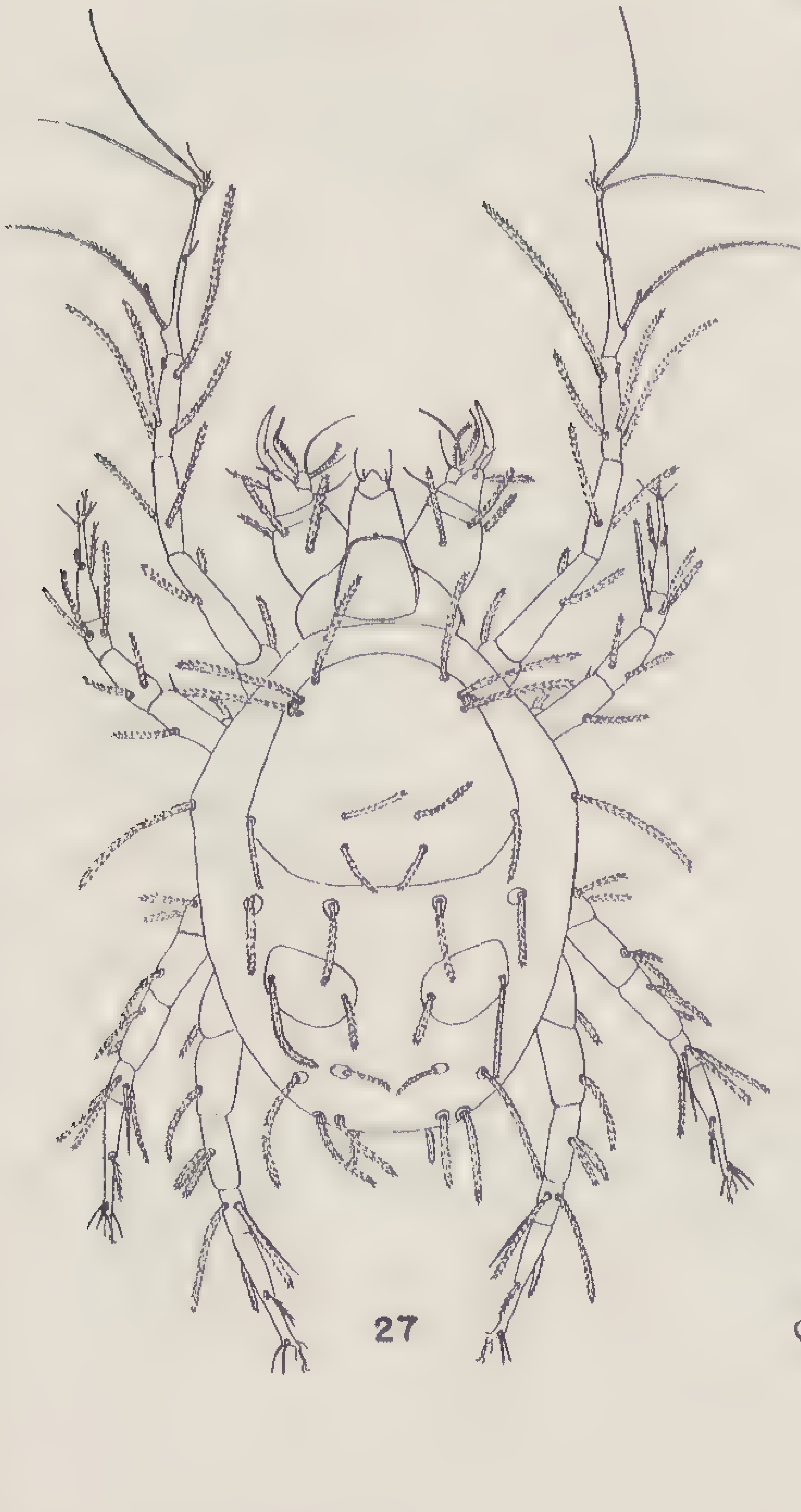

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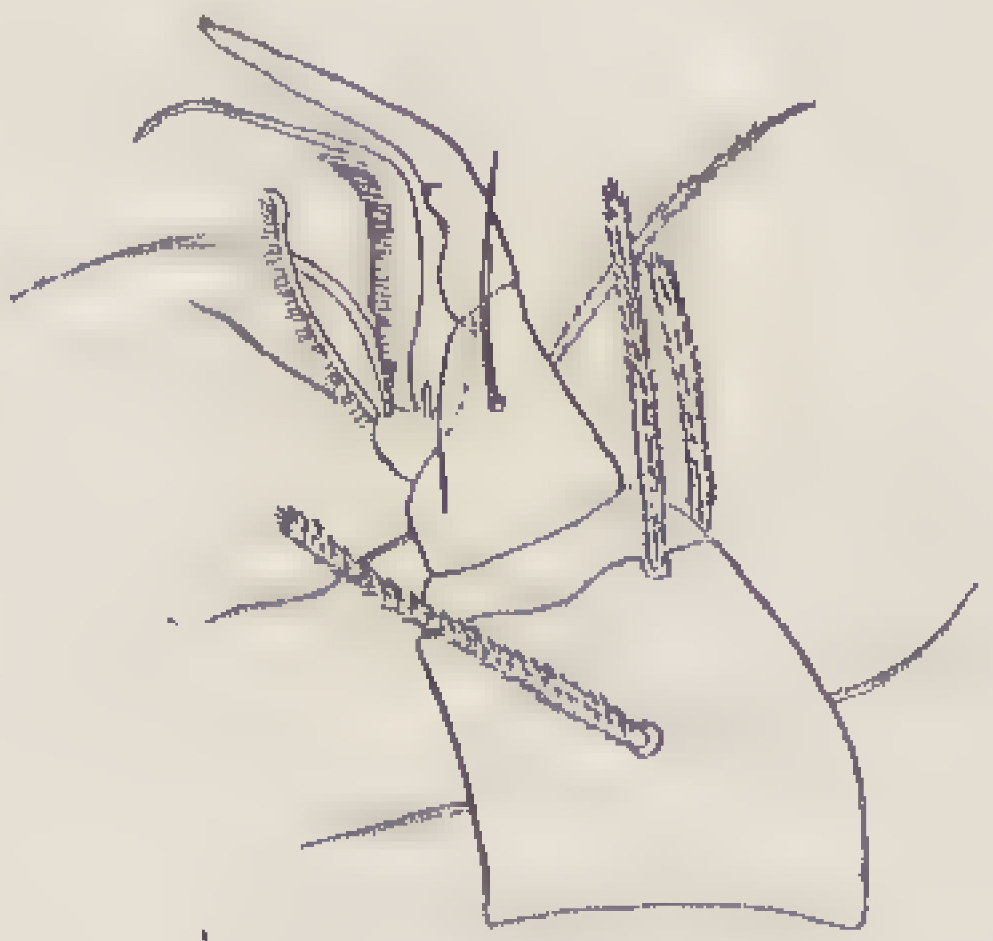

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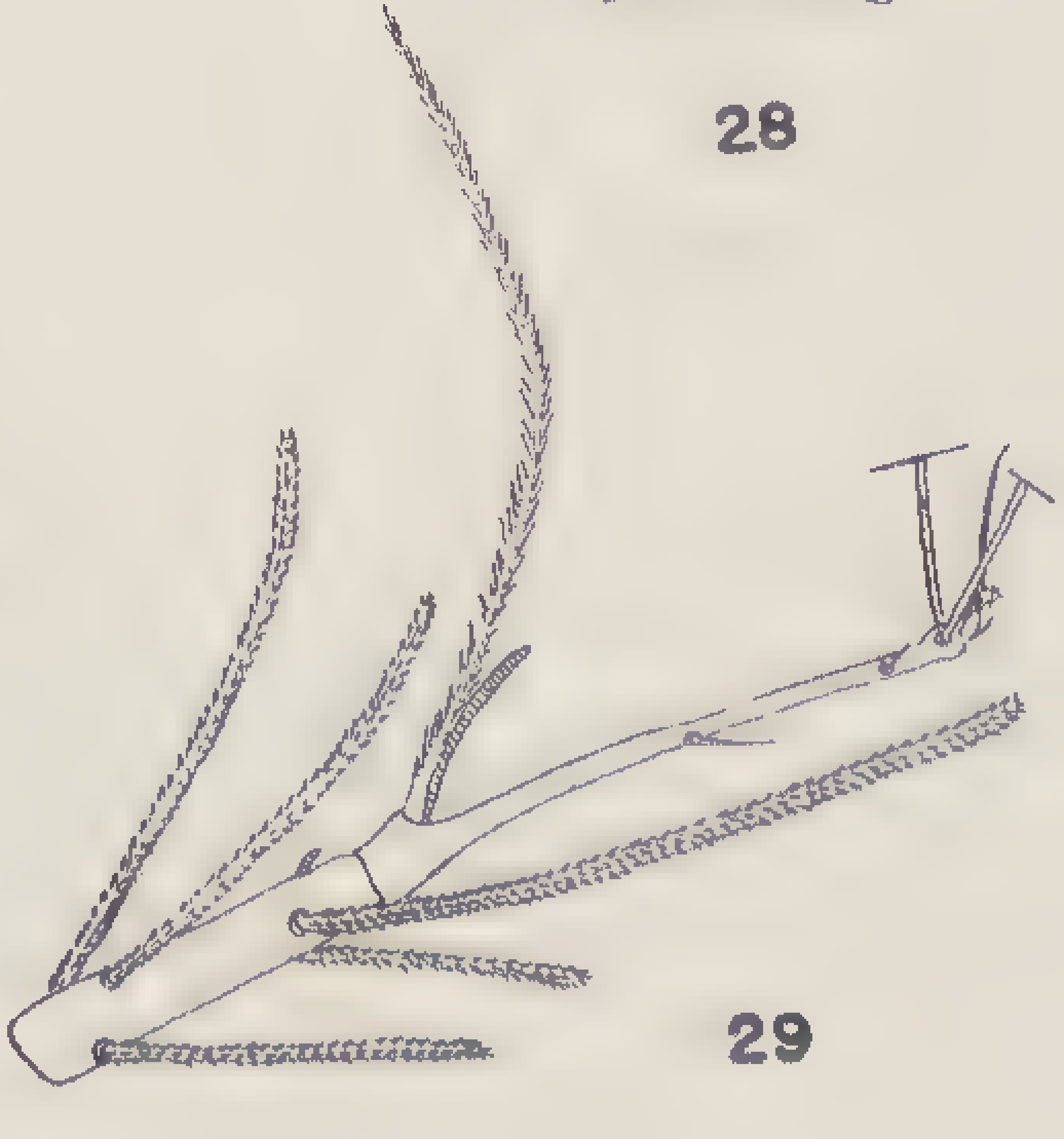

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THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN

VOL. XXXVIII, PT. I] DECEMBER 20, 1956 [No. 6

Comparative Studies of the Thoracic Musculature of Bees *

BY

ALVARO WILLE

ABSTRACT: This paper consists of a study of the thoracic musculature of bees. Fifty-seven genera were dissected representing five families. The musculature of eighty-eight species is described.

Some interpretation of the phylogeny and the functional significance of the muscles are discussed.

Evolutionary trends in the following five muscles are indicated: lateral promotor of the middle coxa, pleurotergal muscle of the mesothorax, median depressor of the abdomen, mesal remotor of the hind coxa, and lateral promotor of the hind coxa.

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INTRODUCTION

This paper is a report of a preliminary study of the thoracic musculature of bees. The purpose of this work is to shed light on the relationships of the groups, the possible modification of muscles in relation to function, and evolutionary trends of the thoracic musculature.

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* Contribution No. 910 from the Department of Entomology of the University of Kansas.

The scope of the work was limited by the specimens available for dissection. Nevertheless, it was possible to examine 88 species representing 57 genera, as follows: Family Colletidae: *Colletes* (2 species), *Ptiloglossa, Hylaeus.* Family Halictidae: *Halictus* (2 species), *Agapostemon, Neocorynura, Corynura, Sphecodes, Temnosoma, Lasioglossum* (2 species), *Coenaugochlora, Augochlora, Augochlorella, Dufourea, Nomia* (3 species). Family Andrenidae: *Andrena* (2 species), *Perdita* (2 species), *Pseudopanurgus, Calliopsis, Protoxaea, Oxaea.* Family Megachilidae: *Megachile* (2 species), *Coelioxys* (2 species), *Heriades, Ashmeadiella, Anthidium, Dianthidium* (2 species), *Paranthidium, Lithurge.* Family Apidae: *Exomalopsis* (3 species), *Ancyloscelis* (2 species), *Paratetrapedia* (3 species), *Tetrapedia, Nomada, Neopasites, Triepoelus, Melissodes* (6 species), *Florilegus, Thygater, Peponapis, Xenoglossa, Xenoglossodes, Ptilothrix, Diadasia* (2 species), *Melitoma, Anthophora* (2 species), *Centris* (2 species), *Epicharis, Xylocopa* (2 species), *Ceratina* (2 species), *Euglossa, Eulaema, Bombus* (5 species), *Melipona, Trigona* (3 species), *Lestrimelitta, Apis.*

ACKNOWLEDGMENT

The author is especially indebted to Dr. C. D. Michener of the University of Kansas for the critical advice and suggestions during this research, for the determination of most of the species, and for obtaining several specimens used in this work. I am also thankful to Wallace E. LaBerge for determining the species of *Melissodes,* and to Earle A. Cross for determining the species of *Nomia.* Thanks are especially due to Maria Bozzoli for aid with the drawings.

METHODS

The specimens were preserved in Kahle's fluid (Dietrich's fluid). Usually 24 hours fixation was adequate but in the larger forms, such as *Bombus* and *Xylocopa,* sometimes several days were required. By soaking dry specimens in either Kahle's solution or alcohol for at least 24 hours, it was possible to study the muscles of a few bees (*Lestrimelitta, Lithurge,* and *Corynura*) not available in fresh condition. This method was not always successful.

Each drawing was made diagramatically from specimens dissected under water. The thorax of each was cut through the mesal plane, after removing the terga. The left section was used to study the metathoracic muscles, and most of the drawings were made from above and slightly toward the right side. The right section was used to study the mesopleural muscles. The mesopleural muscles were drawn from various angles to insure accurate proportions. It should be mentioned that usually several specimens were dissected for every species studied.

MUSCLES STUDIED

In dissecting the muscles the honey bee was used as the standard type, because it is the only species well known morphologically (Morison 1927, Snodgrass 1942). For the musculature the terminology of Snodgrass has been followed, and for the skeletal structures of Michener (1944).

After a general survey it was found that only a few muscles were variable to any considerable degree among the bees. It seems that the variations arise only among those muscles that originate on wide structures, where they actually would have freedom to change.

The muscles selected for study were the following:

Musculature of the Mesopleura

These are the direct muscles of the wing, a pleurotergal muscle and a coxal muscle.

1. *Basalar muscle* (Fig. 3)—This muscle varies very little. It is a two-branched muscle; the anterior branch is small and slender, the posterior one is larger and fan-shaped. Both branches originate on the anterior part of the episternum. The insertion is on the basalare by a long tendonlike apodeme. The posterior branch usually overlaps the inferior part of the second and third pleuroaxillary muscles. The only important modification is seen in the honey bee, in which the two branches are united in one broad muscle (Fig. 56).

2. *Pleuroaxillary muscles*—There are three pleuroaxillary muscles, the first and anteriormost (Fig. 2a, 3) is a small muscle arising in a pocket near the summit of the pleuron. This muscle does not vary much, being confined in the pocket mentioned above. The other two muscles (Fig. 2b, 2c, and 3) are larger and originate ventrally on the episternum. They all insert on the third axillary sclerite.

3. *Pleurotergal muscle* (Fig. 3)—This is a variable muscle. It has its origin on the episternum and its insertion on the lateral margin of the scutum.

4. *Lateral promotor of the middle coxa* (Fig. 3)—This is also a highly variable muscle. It usually arises on the under side and

on the base of the pleural apophysis and on the episternum. It inserts laterally on the base of the middle coxa.

Musculature of the Metathorax

From this region the following muscles were studied: the coxal muscles, the thoracic depressor of the trochanter, and two intersegmental muscles.

5. *Median depressor of the abdomen* (Fig. 70)—This muscle usually originates on the coalesced furcal arms and on the free distal portion of the metafurcal arm. It inserts medially on the sternum of the petiole segment (first metasomal segment).

6. *Ventral lateromotor of the abdomen* (Fig. 21)—This is a rather small muscle arising on the edge of the vertical place of the metasternum. It has its origin either at the posterior part of the edge, or at the anterior part, or along the whole edge. It inserts laterally on the sternum of the petiole segment.

7. *Mesal remotor of the hind coxa* (Fig. 24)—This muscle usually originates on the free basal portion of the metafurcal arm and on the coalesced furcal arms. In some bees fibers also arise on the anterior mesal edge of the intercoxal lamella. It inserts on the posterior basal margin of the hind coxa.

8. *Thoracic depressor of the trochanter* (Fig. 23)—This muscle does not show much variation. It arises on the coalesced furcal arms and on the free distal portion of the metafurcal arm. It inserts in the trochanter of the hind leg.

9. *Lateral promotor of the hind coxa* (Fig. 28)—This muscle arises on the lateral portion of the intercoxal lamella and on the propodeum, just behind the third pleural ridge. The insertion is on the anterior and lateral margin of the hind coxa.

10. *Mesal promotor of the hind coxa* (Fig. 25)—Showing little variation, this muscle originates on the vertical plate of the metasternum, where it is thick, and covers much of the plate (except in the subfamily Megachilinae) (compare Fig. 25 with Fig. 28). Some fibers also may arise on the mesal portion of the intercoxal lamella. Its maximum extension is found in the subfamily Oxaeinae, and the minimum development in *Epicharis* (Fig. 65). The insertion is on the anterior margin of the coxa of the hind leg.

It should be pointed out that a few other muscles, such as the basalar muscle of the metathorax, and the median levator of the abdomen, were variable, but these muscles are not considered in this paper.

PHYLOGENETIC AND FUNCTIONAL SIGNIFICANCE OF THE MUSCLES

Judging by the specimens dissected three general conclusions can be drawn. If two bees have almost identical mesopleural and metathoracic muscles then the two forms are related at or below the subfamily level. The similarity of musculature does not necessarily indicate whether the relation is at the subfamily, tribe, or generic level. Only in one instance did the musculature show relationships above the family. This was the case in the two primitive families, Collitidae and Halictidae, in which the musculature is almost identical in all forms studied (except for the genus *Nomia*). It should be pointed out that Michener (1953) showed a close relationship of these two families and the family Andrenidae on the basis of larval characters. Examples of other bee groups showing almost identical musculature are the following: subfamily Oxaeinae, tribe Meliponini, tribe Euglossini, *Bombus, Ceratina, Xylocopa, Centris, Megachile, Coelioxys, Dianthidium* with *Paranthidium, Perdita.* More species should be dissected to prove or disprove the homogeneity of the musculature in each of these eleven groups. In the genera in which only one species was dissected it is impossible to predict whether additional species have similar or different musculature.

The second conclusion to be drawn from the dissections is that if two bees do not show similarity in either the mesopleura or metathoracic musculature, lack of relationship is not necessarily indicated. This is well illustrated in the honey bee where the worker cast has a different type of mesopleural musculature from that of the male (see Fig. 56 and Fig. 58). Other examples are found among the species of *Nomia, Exomalopsis, Paratetrapedia, Melissodes,* and *Diadasia.*

The last logical conclusion to be drawn is that the modifications of the muscles do not have any obvious relation to function. For instance, *Hylaeus* and *Petiloglossa* are different not only externally but also in behavior, the first being a small slender, weak flyer, the second being a large, robust, fast flying form. Yet both have essentially the same type of musculature, presumably showing their phyletic relationship to one another. On the other hand, different species of the genus *Nomia* differ in the mesopleural muscles although these bees are very similar exteriorly and in behavior (Figs. 6 and 7).

Some of the thoracic muscles in the bees have been modified independently in several groups, while the same muscles have retained an unspecialized condition in others. This has resulted in a great deal of convergence of individual muscles. For example, the lateral promotor of the middle coxa has the same modification in some *Nomia* as in some *Melissodes*, which are quite unrelated forms as judged by many other characters, while it has an unspecialized condition in the family Colletidae, a primitive family, and in the tribe Meliponini, one of the most specialized groups of Apidae. Another example is the lateral promotor of the hind coxa which shows convergence in *Anthidium* and *Thygater;* in both forms the inner lobe has been eliminated. Another specialization of the same muscle is the elimination of the outer lobe instead of the inner one, which has been accomplished independently in *Neopasites* and *Apis.*

TRENDS OF SPECIALIZATION OF SOME OF THE MUSCLES

It was possible to trace the probable trends of specialization for at least half of the muscles studied. The Colletidae and Halictidae (except *Nomia*) are the only families of bees which exhibit almost identical mesopleural and metathoracic muscles; the other groups show a great deal of variation. These modifications are easily traceable and are derived from the pattern found in the Colletidae and Halictidae. On the basis of this, a table was made listing five supposed unspecialized types on the left, and their specialized alternatives on the right. It should be mentioned that intermediate conditions occur.

Unspecialized	*Specialized*
1. Lateral promotor of the middle coxa fan-shaped.	1. Lateral promotor of the middle coxa V-shaped or ribbonlike.
2. Pleurotergal muscle of the mesothorax twice or almost twice as long as wide.	2. Pleurotergal muscle of the mesothorax as long as wide.
3. Median depressor of the abdomen a triangular muscle.	3. Median depressor of the abdomen ribbonlike.
4. Mesal remotor of the hind coxa not fused anteriorly with the thoracic depressor of the hind trochanter.	4. Mesal remotor of the hind coxa fused anteriorly with the thoracic depressor of the hind trochanter.
5. Lateral promotor of the hind coxa with both outer and inner lobe.	5. Lateral promotor of the hind coxa with only one of the lobes.

Lateral Promotor of the Middle Coxa (Fig. 1)

As indicated above, the unspecialized type is a fanshaped muscle found in all Collitidae and Halictidae (12 genera) except *Nomia.** The main trend of specialization of this muscle is to become V-shaped by the formation of an inferior arm. In the family Andrenidae two genera, *Andrena* and *Pseudopanurgus,* six dissections were found with the fan-shaped type, and in one of these (*Pseudopanurgus*) the muscle already has some of the inferior fibers extended anteriorly. In Megachilidae four genera (*Heriades, Ashmeadiella, Coelioxys, Anthidium*) eight dissections exhibit the fan-shaped type, but *Coelioxys* and *Anthidium,* like *Pseudopanurgus,* have some of the inferior fibers of the muscle extended anteriorly, without forming a true inferior arm. In the family Apidae only nine genera of the twenty-eight dissected have retained the unspecialized type. The genera showing this condition are the following: *Neopasites, Thygater, Peponapis, Melitoma, Centris, Anthophora* and the tribe Meliponini. Of these genera, *Neopasites* has some of the inferior fibers well extended anteriorly, almost forming an inferior arm. On the other hand, *Thygater, Melitoma,* and *Anthophora* show partial splitting of the muscle.

It should be mentioned that usually in the V-shaped type the superior fibers arise on the under side and on the base of the pleural apophysis, and the inferior arm on the episternum leaving a weak area in the middle of the muscle. Perhaps because the pull of the muscle is made by the fibers which are attached to the pleural apophysis and by the inferior arm, the area in the middle becomes concave and somewhat overlapped by the inferior arm and superior fibers. This gives the impression of a muscle having a superior arm, but this is actually the case only when the area in the middle is eliminated or partially so, as in many bees.

Two further specializations can be followed from the V-shaped lateral promotor of the middle coxa. One of these is the enlargement of the inferior arm as in *Melissodes obiqua, Diadasia enevata, Nomia mortoni, Bombus medius* and *Nomada.* The other line is the elimination of the inferior arm. This is well illustrated in the honey bee. In the worker cast the lateral promotor is a V-shaped muscle with the inferior arm not enlarged, while in the male only the superior arm is present. Among the thirty males dissected one specimen was found with an intermediate condition (Fig. 57).

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* In order to avoid needless repetition only the generic name is used either when one species has been dissected in the genus or when all the species of a genus have the same type of muscle under discussion.

It is surprising that in *Vespula* the lateral promotor of the middle coxa does not originate on the mesopleura (Duncan 1939). But according to Maki (1938) in *Vespa* ". . . there is a strong pleural abductor arising on the episternum near the pleural ridge by a very broad base and attached on the anterolateral basal rim of the coxa by a tendon." (pp. 234.)

Pleurotergal Muscles of the Mesothorax

The pleurotergal muscle shows some correlations with the lateral promotor of the middle coxa. The unspecialized type is a dorsoventrally elongated muscle twice or almost twice as long as wide, with a broad base. The inferior end is at the same level or a little above that of the inferior end of the third pleuroaxillary muscle. This type is found in Collitidae, Halictidae (except *Nomia*), *Andrena* (one of the two species dissected), *Ashmeadiella, Peponapis, Xenoglossa* and *Apis* (males only). It is correlated with the fan-shaped type of lateral promotor of the middle coxa, or if the latter is V-shaped, as in *Xenoglossa,* the inferior arm is very slender. A modification from this type is found in *Andrena argemonis, Psuedopanurgus, Coelioxys, Anthidium,* and *Neopasites,* in which the inferior end of the muscle is pointed, forming a rather leaf-shaped muscle. This shape is also correlated with the fan-shaped type of lateral promotor, but the latter has a tendency to have the inferior fibers extended anteriorly, following the contour of the pleurotergal muscle.

From these apparently less-specialized types arises a series of different kinds of pleurotergal muscles. Probably the most specialized type of this series is a rounded or quadrangular muscle, as long as wide and tending to be above the level of the inferior end of the third pleuroaxillary muscle. This type is usually correlated with a V-shaped lateral promotor of the middle coxa. It is found in *Nomia (Dieunomia), Calliopsis, Perdita, Oxaea, Protoxaea, Megachile, Exomalopsis, Ancyloscelis, Nomada, Triepeolus, Melissodes, Thygater, Ptilothrix, Epicharis, Ceratina, Xylocopa, Diadasia,* and *Bombus.*

Median Depressor of the Abdomen

In all the bees dissected, except those mentioned below, the median depressor of the abdomen is a large, triangular muscle arising on the coalesced furcal arms and on the free distal portion of the metafurcal arm, usually occupying the entire posterior surface of the dorsal process. A modification of this type is a rather ribbonlike muscle with the origin restricted to the coalesced furcal arms. This type is found in *Perdita, Nomada, Neopasites* (with few fibers on the free distal portion of metafurcal arm), *Anthophora, Ceratina* (last two genera with few fibers on mesofurcal bridge) and *Centris* (but triangular in shape). In the tribe Meliponini, including *Trigona, Melipona,* and *Lestrimelitta,* the origin is only on the mesal half of the coalesced furcal arms. Still a further modification is found in *Apis* in which the muscle is very slender, arising on the basal portion of the metafurcal arm.

Mesal Remotor of the Hind Coxa

In most bees this muscle is divided into outer and inner parts. Intermediate conditions occur between a well-divided muscle (Fig. 26) and one in which no division can be detected (Fig. 24). This is well exemplified in the subfamily Halictinae. In *Halictus* the two parts are well fused. In *Augochlora* the division is more or less evident, while in *Coenaugochlora* the muscle is well divided.

A highly specialized type is that found in *Bombus;* the muscle is fused along all the anterior part with the thoracic depressor of the hind trochanter (Fig. 70). This is also accomplished in smaller degree in *Epicharis.* Another modification is the reduction of the outer part leaving only a ribbonlike muscle as in *Ceratina* and *Apis.*

Lateral Promotor of the Hind Coxa (Fig. 2)

This somewhat triangular muscle can be said to be composed of two lobes. The inner lobe arises on the lateral part of the intercoxal lamella, just behind the anterior edge. The outer lobe originates, partly on the intercoxal lamella and partly on the propodeum, just behind the metapleural ridge. The great majority of bees have retained this type of arrangement. Nevertheless three lines of specialization can be followed. In one, the whole muscle extends over the lateral part of the intercoxal lamella. This trend can be observed in the family Andrenidae. In *Andrena, Calliopsis, Perdita,* and *Pseudopanurgus* the muscle is already well extended and fan-shaped, while in the subfamily *Oxaeinae* the lateral promotor of the hind coxa reaches the highest development (Fig. 25).

In the other two lines of specialization either the outer or inner lobe tends to be eliminated. The suppression of the inner lobe is well illustrated in certain genera of the family Megachilidae. In *Heriades* and *Anthidium* the inner lobe is already very small, while in *Dianthidium, Paranthidium,* and *Ashmeadiella* the same lobe is completely eliminated. The same trend is observed in the tribe Eucerini (family Apidae) in which *Peponapis* has a small inner lobe while in *Thygater* the same lobe is absent. The elimination of the outer lobe was observed only in *Neopasites* and *Apis* (family Apidae). In the genera *Exomalopsis* (2 species of the 3 dissected), *Melissodes, Florilegus, Epicharis, Anthophora* and *Xylocopa* the lobes of the lateral promotor of the hind coxa are well separated by a notch.

It should be mentioned that the specialization of the lateral promotor of the hind coxa shows a remarkable parallelism with that of the lateral promotor of the middle coxa. The specializations of these two muscles are not correlated, however. The muscle splits, forming outer and inner lobes (corresponding to superior and inferior arms of the lateral promotor of the middle coxa). The elimination of the inner lobe (*Anthidium*) or inferior arm (*Apis* males) also occurs in both muscles.

DESCRIPTIVE ACCOUNTS

FAMILY COLLETIDAE

Only three genera were dissected in this family, but all the three forms presented almost identical musculature.

Subfamily COLLETINAE

TRIBE COLLETINI

Colletes sp.

(Female. Carmen, Hidalgo, Mex., July 22, 1954)

Mesopleura divided into anterior and posterior parts by preepisternal ridge. Basalar and pleuroaxillary muscles in front of ridge. Third pleuroaxillary overlapping posterior section of the second; pleurotergal and lateral promotor of middle coxa on posterior part of pleura. Pleurotergal muscle dorsoventrally elongated; lateral promotor of middle coxa fan-shaped (Fig. 3). In *metathorax* median depressor of abdomen a large triangular muscle, originating on coalesced furcal arms and on free distal portion of metafurcal arm. Ventral lateromotor of abdomen small, arising on posterior ridge of vertical plate of metasternum. Mesal remotor of hind coxa well divided posteriorly, outer part on mesal section of coalesced furcal arms and on free basal portion of metafurcal arm, inner part on base of metafurcal arm. Thoracic depressor of hind coxa on coalesced furcal arms and on free distal portion of metafurcal arm, few fibers on lateral portion of intercoxal lamella. Lateral promotor of hind coxa well lobed. Mesal promotor of hind coxa not covering small section anteriorly of mesal portion of intercoxal lamella.

Colletes sp.

(Female. Xilitla, S. L. P., Mex., July 25, 1954)

This species agrees with the description of the previous one.

TRIBE CAUPOLICANINI

Ptiloglossa mexicana (Cresson)

(Female)

This species agrees with *Colletes* in nearly all details. The following differences exist: Outer part of median remotor of hind coxa overlapping inner part anteriorly (Fig. 21); thoracic depressor of hind trochanter without fibers arising on intercoxal lamella. Lateral promotor of hind coxa not so well lobed. Mesal promotor of hind coxa almost covering mesal portion of intercoxal lamella.

Subfamily HYLAEINAE

Hylaeus pygmaeus Cresson

(Female)

This species agrees with the description of *Colletes*.

FAMILY HALICTIDAE

The musculature of the genera dissected (except *Nomia*) agrees essentially with that of the family Colletidae (Fig. 4 and 5).

Subfamily HALICTINAE

The following species were dissected: *Halictus (Halictus) ligatus* Say (female), *Halictus (Seladonia) hesperus* Smith (worker, queen and male), *Agapostemon radiatus* (Say) male and female, *Neocorynura* sp. (female, Xilitla, S. L. P., Mex., July 25, 1954), *Corynura rubella* (Haliday) female, *Sphecodes* sp. (female, Filadelfia, Guanacaste, Costa Rica, March 1954), *Temnosoma smaragdinum* Smith (female), *Lasioglossum (Paralictus) cephalotes* (Dalla Torre), *Lasioglossum (Chloralictus)* (worker, Lawrence, Kansas, June, 1954), *Coenaugochlora nigromarginata* (Spinola) female, *Augochlorella aurata* (Smith) female, *Augochlora pura* Say (female).

Halictus ligatus Say

In comparing this species with that of *Colletes* the following points should be mentioned. Ventral lateromotor of abdomen arises along ridge of vertical plate of metasternum. Mesal remotor of hind coxa not divided, originating on coalesced furcal arms and on free basal portion of metafurcal arm. Thoracic depressor of hind trochanter without fibers arising on intercoxal lamella. Lateral promotor of hind coxa not so well lobed. Mesal promotor of hind coxa covering the mesal portion of intercoxal lamella.

All the species of the Halictinae dissected agree with the description of *Halictus ligatus.* A few differences, however, were noted. In *Halictus hesperus, Augochloropsis, Augochlorella, Augochlora,* and *Coenaugochlora* the pleurotergal muscle is wider at the inferior end. In *Sphecodes* the second pleuroaxillary muscle is very narrow. In *Augochlora* and *Coenaugochlora* the mesal remotor of the hind coxa is divided.

Subfamily DUFOUREINAE

Dufourea marginata (Cresson)

(Female)

The musculature of this species is similar to that of *Halictus ligatus*, but differs in having second pleuroaxillary muscle more extended posteriorly (Fig. 5), and ventral lateromotor of abdomen originating on posterior ridge of vertical plate of metasternum, as is the Colletidae.

Subfamily NOMIINAE

This group differs from the other two subfamilies in the mesopleural musculature.

Nomia (Acunomia) nortoni Cresson

(Male)

Mesopleura not divided by pre-episternal ridge. Lateral promotor of middle coxa with wide inferior arm. Pleurotergal muscle above level of inferior end of third pleuroaxillary muscle. Third pleuroaxillary muscle posteriorly overlapping inferior arm of lateral promotor, and anteriorly second pleuroaxillary muscle (Fig. 6). *Metathoracic musculature* (Fig. 22) agreeing with description of *Colletes* except as follows: ventral lateromotor of abdomen arises along ridge of vertical plate of metasternum; outer part of mesal remotor of hind coxa originating on coalesced furcal arms and on free basal portion of metafurcal arm.

Nomia (Epinomia) micheneri Cross

(Male)

Mesopleura divided by pre-episternal ridge. Lateral promotor of middle coxa with slender inferior arm. Third pleuroaxillary muscle not overlapping either lateral promotor or pleurotergal muscle (Fig. 7). *Metathoracic musculature* as in *N. nortoni,* but thoracic depressor of hind trochanter without fibers arising on intercoxal lamella. Lateral promotor of hind coxa not as well lobed, and mesal promotor of hind coxa covering mesal portion of intercoxal lamella.

Nomia (*Dieunomia*) sp.

(Female. Western Kansas)

Mesopleura divided by pre-episternal ridge. Lateral promotor with wide inferior arm but not as wide as in *N. nortoni.* Pleurotergal muscle small and rather rounded. Third pleuroaxillary muscle overlapping posteriorly inferior arm of lateral promotor and pleurotergal muscle, but not overlapping anteriorly second pleuroaxillary muscle (Fig. 8). *Metathoracic musculature* agrees with that of *N. micheneri.*

FAMILY ANDRENIDAE

All the six genera dissected agree in having the lateral promotor of the hind coxa well extended on lateral portion of the intercoxal lamella. The indication of the outer and inner lobes are suppressed by the rather fan-shaped muscle. The mesal promotor of the hind coxa almost covers the mesal portion of the intercoxal lamella.

Subfamily ANDRENINAE

Andrena argemonis Cockerell

(Male)

Third pleuroaxillary muscle of *mesopleura* posteriorly overlapping anterior half of pleurotergal muscle. Pleurotergal muscle dorsoventrally elongated, but with inferior end pointed, leaf-shaped. Lateral promotor of middle coxa fan-shaped, as in the Colletidae (Fig. 9). In *metathorax* median depressor of abdomen a large triangular muscle, originating on coalesced furcal arms and on free distal portion of metafurcal arm. Ventral lateromotor of abdomen on posterior ridge of vertical plate of metasternum. Mesal remotor of hind coxa well divided posteriorly, outer part triangular in shape, originating on free basal portion of metafurcal arm, on coalesced furcal arms, and few fibers on free distal portion of metafurcal arm; inner part ribbonlike and arising on base of metafurcal arm. Thoracic depressor of hind trochanter on coalesced furcal arms and on free distal portion of metafurcal arm (Fig. 23).

Andrena sp.

(Female. Pachuca, Hidalgo, Mex., July 29, 1954)

This species agrees with the description of the previous one in nearly all details. The following differences were noted: third pleuroaxillary muscle of mesopleura posteriorly overlapping less than half of pleurotergal muscle; pleurotergal muscle not leaf-shaped; in the metathorax the outer part of mesal remotor of hind coxa arising only on free basal portion of metafurcal arm.

Subfamily PANURGINAE

The species dissected agree in having the mesal remotor of the hind coxa either not divided or the division not evident.

TRIBE PANURGINI

Perdita (*Cockerellia*) sp.

(Female. Acapulco, Mex., August 6, 1954)

Mesopleura musculature different from that of *Andrena.* Second and third pleuroaxillary muscles overlapping anterior part of pleurotergal and lateral promotor of middle coxa. Pleurotergal muscle rounded and above level of inferior end of third pleuroaxillary. Lateral promotor of middle coxa V-shaped (Fig. 10). In *metathorax* median depressor of abdomen a ribbonlike muscle, arising on coalesced furcal arms. Ventral lateromotor of abdomen on posterior half of vertical plate of metasternum. Mesal remotor of hind coxa divided but not evident, because outer part somewhat overlaps inner part; outer part on coalesced furcal arm, and on free basal portion of metafurcal arm, inner part on base of metafurcal arm. Thoracic depressor of hind trochanter on lateral section of coalesced furcal arm and on free distal portion of metafurcal arm.

Perdita sp.

(Female. Llera, Tamaulipas, Mex., July 20, 1954)

This species agrees with the description of the previous one.

Pseudopanurgus sp.

(Female. Lagos de Moreno, Jalisco, Mex., August 21, 1954)

Mesopleura musculature somewhat similar to that of *Andrena argemonis* (Fig. 11). But *metathoracic musculature* differs from it as follows: ventral lateromotor of abdomen arises along ridge of vertical plate of metasternum; mesal remotor of hind coxa not divided, arising on free distal portion of metafurcal arm, on coalesced furcal arms, and on free basal portion of metafurcal arm (Fig.

24); thoracic depressor of hind trochanter a ribbonlike muscle, originating on coalesced furcal arms, some fibers attach to lateral promotor of hind coxa.

Calliopsis sp.

(Female. Carmen, Hidalgo, Mex., July 30, 1954)

Mesopleura musculature somewhat similar to that of *Perdita* (Fig. 12), but third pleuroaxillary muscle smaller and overlapping section of second. Methathoracic musculature agrees with description of *Pseudopanurgus.*

Subfamily OXAEINAE

The species in this group are characterized by the great development of the lateral and mesal promotors of the hind coxa, both muscles cover completely the intercoxal lamella (Fig. 25).

Protoxaea nigerrima (Friese)

(Female)

Mesopleura musculature somewhat similar to that of *Calliopsis* (Fig. 13), but third pleuroaxillary muscle large. Second pleuroaxillary ribbonlike. In *metathorax* median depressor of abdomen as in *Andrena.* Ventral lateromotor of abdomen on posterior half of vertical plate of metasternum, as in *Perdita.* Mesal remotor of hind coxa well divided posteriorly, outer part on free distal portion of metafurcal arm, on coalesced furcal arms, and on free basal portion of metafurcal arm; inner part ribbonlike and arising on base of metafurcal arm. Thoracic depressor of hind trochanter on coalesced furcal arm.

Oxaea sp.

(Female. Independencia, Paraguay, February 20, 1951)

The musculature of this species agrees with the description of *Protoxaea nigerrima.*

FAMILY MEGACHILIDAE

Subfamily MEGACHILINAE

All the species dissected in this group agree in having a thin and transparent plate which originates from the coalesced furcal arms and the free basal portion of the metafurcal arm. The furcal plate (as it is here called) attaches along the mesal portion of the intercoxal lamella, covering the anterior ridge (Fig. 28). It should be mentioned that the mesal promotor of the hind coxa originates at the base of the vertical plate of the metasternum (Fig. 28).

TRIBE MEGACHILINI

Megachile sp.

(Female. Taxco, Guerrero, Mex., August 8, 1954)

Third pleuroaxillary muscle of *mesopleura* overlapping part of second pleuroaxillary, and part of pleurotergal and lateral promotor of middle coxa. Pleurotergal muscle rounded; lateral promotor of middle coxa with inferior arm (Fig. 14). In *metathorax* median depressor of abdomen a large triangular muscle, originating on coalesced furcal arms and on free distal portion of metafurcal arm. Ventral lateromotor of abdomen on anterior ridge of vertical plate of metasternum, some fibers on free basal portion of metafurcal arm. Mesal remotor of hind coxa well divided (Fig. 26), outer part on furcal lamella, inner part arises along the attachment of furcal lamella to mesal portion of intercoxal lamella, and on base of metafurcal arm. Thoracic depressor of hind trochanter on free distal portion of metafurcal arm, and on lateral half of coalesced furcal arm. Lateral promotor of hind coxa well extended but lobed, anterior end of inner lobe under furcal lamella (Fig. 28).

Megachile sp.

(Male. Edinburg, Texas, July 17, 1954)

This species agrees with the description of the previous one.

Coelioxys sp.

(Female. Lawrence, Kan., June 3, 1954)

Mesopleura musculature similar to that of *Andrena argemonis* (Fig. 15). *Metathoracic musculature* like that of *Megachile* but parts of mesal remotor of hind coxa not widely separated posteriorly.

Coelioxys sp.

(Female. Xilitla, S. L. P., Mex., July 25, 1954)

The musculature of this species is like the previous one.

Heriades variolosa purpurascens Cockerell

(Male)

Mesapleural musculature somewhat resembles that of *Coelioxys* (Fig. 17), but pleurotergal muscle rounded and not overlapped anteriorly by second pleuroaxillary. In comparing the *metathoracic musculature* with that of *Megachile* the following differences are noted: ventral lateromotor of abdomen arises along ridge of vertical plate of metasternum, some fibers on free basal portion of metafurcal arm; parts of mesal remotor of hind coxa not widely separated posteriorly, as in *Coelioxys;* lateral promotor of hind coxa with small inner lobe.

Ashmeadiella opuntiae (Cockerell)

(Male)

Mesopleural musculature similar to that of *Heriades variolosa* (Fig. 16). *Metathoracic musculature* differs from that of *Megachile* as follows: Ventral lateromotor arises along ridge of vertical plate of metasternum. Outer part of lateral promotor of hind coxa on mesal half of coalesced furcal arms (or furcal plate), and on free basal portion of metafurcal arm, both parts not widely separated posteriorly, as in *Coelioxys* and *Ashmeadiella,* lateral promotor of hind coxa without inner lobe.

TRIBE ANTHIDIINI

The species dissected in this tribe were found with the mesal remotor of the hind coxa not divided.

Anthidium maculosum Cresson

(Female)

Mesopleural musculature similar to that of *Coelioxys* (Fig. 18), but second pleuroaxillary muscle smaller. *Metathoracic musculature* differs from that of *Megachile* as follows: mesal remotor of hind coxa not divided; lateral promotor of hind coxa with small inner lobe (in one specimen inner lobe absent) Fig. 27.

Dianthidium sayi Cockerell

(Male and Female)

In *mesopleura* pleurotergal muscle dorsoventrally elongated. Lateral promotor of middle coxa V-shaped with slender inferior arm (Fig. 19). *Metathoracic musculature* like that of *Megachile* but mesal remotor of hind coxa not divided, and lateral promotor of hind coxa without inner lobe.

Dianthidium sp.

(Female. Padilla, Tamaulipas, Mex., August 26, 1954)

The musculature of this species is like the previous one.

Paranthidium sp.

(Female. Taxco, Guerrero, Mex., August 8, 1954)

The musculature of this species agrees with the description of *Dianthidium.*

Subfamily LITHURGINAE

This subfamily contains only the genus *Lithurge*, and the only species dissected does not have the furcal plate.

Lithurge sp.

(Female. El Peumo, Chile. December 28, 1950)

In *mesopleura* third pleuroaxillary muscle overlapping only anterior part of pleurotergal and lateral promotor of middle coxa. Lateral promotor with somewhat slender inferior arm (Fig. 20). In comparing the *metathoracic musculature* with that of *Megachile* the following difference is noted: mesal remotor of hind coxa not divided, arising on coalesced furcal arms and on free basal portion of metafurcal arm.

FAMILY APIDAE

The bees in this family exhibit considerable diversity in their musculature.

Subfamily ANTHOPHORINAE

TRIBE EXOMALOPSINI

Exomalopsis sp.

(Female. El Puente, Jalisco, Mex., August 20, 1954)

In *mesopleura* second and third pleuroaxillary muscles overlapping anterior part of pleurotergal and lateral promotor of middle coxa. Third pleuroaxillary small, with long tendonlike apodeme. Pleurotergal muscle fan-shaped and above level of inferior end of third pleuroaxillary. Lateral promotor of middle coxa V-shaped, with long inferior arm (Fig. 29). In *metathorax* median depressor of abdomen a large triangular muscle arising on free distal portion of metafurcal arm, and on coalesced furcal arms. Ventral lateromotor of abdomen a small muscle originating on posterior ridge of vertical plate of metasternum. Mesal remotor divided, outer part triangular-shaped and arising on free distal portion of metafurcal arm, on coalesced furcal arms, and on free basal portion of metafurcal arm; inner part on basal portion of metafurcal arm, and on anterior ridge of mesal portion of intercoxal lamella; outer part overlaps inner part anteriorly. Thoracic depressor of hind trochanter on free distal portion of metafurcal arm and on coalesced furcal arms. Lateral promotor of hind coxa with outer and inner lobes separated by a notch. Mesal promotor of hind coxa not covering whole mesal portion of intercoxal lamella (Fig. 59).

Exomalopsis sp.

(Female. San Fernando, Tamaulipas, Mex., August 27, 1954)

Mesopleura musculature differs from above species as shown in Fig. 30. *Metathoracic musculature* differs as follows: ventral lateromotor of abdomen arising along ridge of vertical plate of metasternum; lateral promotor of hind coxa not divided by a notch.

Exomalopsis snowi Cockerell

(Female)

The description of this species agrees with the above species except that the lateral promotor of the hind coxa is divided by a notch.

Ancyloscelis armatus Smith

(Female)

In *mesopleura* third pleuroaxillary muscle overlapping anterior part of pleurotergal and lateral promotor of middle coxa. Pleurotergal muscle fanshaped. Lateral promotor of middle coxa V-shaped (Fig. 31). In comparing the *metathoracic musculature* with that of *Exomalopsis* the following differences were noted: ventral lateromotor of abdomen arising along edge of vertical plate of metasternum (which is very short); mesal remotor of hind coxa apparently without division and only few fibers arising on free distal portion of metafurcal arm; lateral promotor of hind coxa not divided by a notch.

Ancyloscelis sp.

(Female. Xilitla, S. L. P., Mex., July 25, 1954)

Mesopleura musculature agrees with description of *Exomalopsis* (from El Puente), except that third pleuroaxillary muscle is larger than second, and inferior arm of lateral promotor of middle coxa not so wide. In *metathorax* ventral lateromotor of abdomen arising along edge of vertical plate of metasternum (which is very short). Mesal remotor of hind coxa apparently without division and only a few fibers arising on free distal portion of metafurcal arm. Lateral promotor of hind coxa not divided by a notch.

Paratetrapedia sp.

(Male. Xilitla, S. L. P., Mex., July 24, 1954)

In *mesopleura* third pleuroaxillary muscle overlapping only small section of pleurotergal and lateral promotor of middle coxa. Pleurotergal muscle leaf-shaped. Lateral promotor of middle coxa V-shaped, with arched arms (Fig. 32). *Metathoracic musculature* differs from that of *Exomalopsis* as follows: Mesal remotor of hind coxa not divided and with few fibers arising on free portion of metafurcal arm, as is in *Ancyloscelis.* Lateral promotor of hind coxa not divided by a notch, as in *Ancyloscelis.*

Paratetrapedia sp.

(Male. Xilitla, S. L. P., Mex., July 24, 1954)

Mesopleura musculature somewhat similar to that of the above species (Fig. 33), but third pleuroaxillary muscle not as large, and lateral promotor of middle coxa without arched arms. *Metathoracic musculature* similar to that of *Exomalopsis,* with the following differences: outer part of mesal remotor of hind coxa arising on coalesced furcal arms and on free basal portion of metafurcal arm; lateral promotor of hind coxa not divided by a notch.

Paratetrapedia sp.

(Female. Xilitla, S. L. P., Mex., July 24, 1954)

In *mesopleura* second and third pleuroaxillary muscle overlapping anterior section of pleurotergal and lateral promotor of middle coxa. Pleurotergal muscle elongated dorsoventrally, but above inferior level of third pleuroaxillary. Lateral promotor of middle coxa V-shaped (as in Fig. 34). *Metathoracic musculature* similar to that of *Exomalopsis,* but ventral lateromotor of abdomen arising along ridge of vertical plate of metasternum; division of mesal remotor of hind coxa not well marked; lateral promotor of hind coxa not divided by a notch.

Tetrapedia maura Cresson

(Female)

Mesopleura musculature agrees with description of above species (Fig. 34). *Metathoracic musculature* similar to that of *Exomalopsis,* but mesal remotor of hind coxa apparently without division, and lateral promotor of hind coxa not divided by a notch.

Tribe NOMADINI

Nomada (*Micronomada*) sp.

(Male. San Luis Potosi, S. L. P., Mex., August 22, 1954)

In *mesopleura* third pleuroaxillary muscle not overlapping second one, but overlapping anterior part of pleurotergal and lateral promotor of middle coxa. Pleurotergal muscle quadrangular in shape and above level of inferior end of third pleuroaxillary muscle. Lateral promotor V-shaped, with wide inferior arm (Fig. 35). In *metathorax* median depressor of abdomen a ribbonlike muscle, arising on coalesced furcal arms. Ventral lateromotor of abdomen small muscle originating on anterior ridge of vertical plate of metasternum. Mesal remotor of hind coxa divided, outer part on mesal half of coalesced furcal arms and on free basal portion of metafurcal arm, inner part on basal portion of metafurcal arm and on vertical plate of metasternum. Thoracic depressor of hind trochanter on free distal portion of metafurcal arm and on coalesced furcal arms. Lateral promotor of hind coxa with small inner lobe. Mesal promotor of hind coxa covering whole mesal portion of intercoxal lamella.

TRIBE NEOPASITINI

Neopasites sp.

(Female. Lawrence, Kan., June 4, 1954)

In *mesopleura* third pleuroaxillary muscle overlapping part of second one anteriorly and part of pleurotergal posteriorly. Pleurotergal muscle leaf-shaped. Lateral promotor of middle coxa fan-shaped, with inferior fibers extended anteriorly (Fig. 36). In *metathorax* median depressor of abdomen a rather ribbonlike muscle arising on mesal part of free distal portion of metafurcal arm, and on coalesced furcal arms. Ventral lateromotor of abdomen originating along ridge of vertical plate of metasternum. Mesal remotor of hind coxa divided, outer part on mesal half of coalesced furcal arms and on free basal portion of metafurcal arm, inner part on basal portion of metafurcal arm and an anterior ridge of mesal portion of intercoxal lamella. Thoracic depressor of hind trochanter on mesal part of free distal portion of metafurcal arm and on lateral part of coalesced furcal arms. Lateral promotor of hind coxa a fan-shaped muscle, without the outer lobe. Mesal promotor of hind coxa not covering whole mesal portion of intercoxal lamella.

TRIBE EPEOLINI

Triepeolus sp.

(Female. Mexico City, August 3, 1954)

In *mesopleura* third pleuroaxillary a large muscle, overlapping part of second one anteriorly, and part of pleurotergal and lateral promotor of middle coxa posteriorly. Pleurotergal muscle above level of inferior end of third pleuroaxillary. Lateral promotor of middle coxa V-shaped (Fig. 37). In *metathorax* median depressor of abdomen a large triangular muscle arising on free distal portion of metafurcal arm, and on coalesced furcal arms. Ventral lateromotor of abdomen a small muscle originating on anterior ridge of vertical plate of metasternum. Mesal remotor of hind coxa divided, outer part on free basal portion of metafurcal arm, inner part on basal portion of metafurcal arm (Fig. 60). Thoracic depressor of hind trochanter on free distal portion of metafurcal arm and on coalesced furcal arms. Lateral promotor of hind coxa lobed. Mesal promotor of hind coxa covering whole mesal portion of intercoxal lamella.

TRIBE EUCERINI

Melissodes (Epimelissodes) obliqua Say

(Female)

In *mesopleura* third pleuroaxillary muscle overlapping anterior part of pleurotergal and lateral promotor of middle coxa. Pleurotergal muscle small and rounded, above level of inferior end of third pleuroaxillary. Lateral promotor of middle coxa V-shaped, with very wide inferior arm (Fig. 38). In *metathorax* median depressor of abdomen a large triangular muscle arising on free distal portion of metafurcal arm, and on coalesced furcal arms. Ventral lateromotor of abdomen a rather triangular-shaped muscle arising along ridge of vertical plate of metasternum. Mesal remotor of hind coxa divided, outer part on free distal portion of metafurcal arm, on coalesced furcal arms, and on free basal portion of metafurcal arm, inner part on basal portion of metafurcal arm and anterior ridge of mesal portion of intercoxal lamella. Thoracic depressor of hind trochanter on free distal portion of metafurcal arm and on coalesced furcal arms. Lateral promotor of hind coxa with outer and inner lobes separated by a notch. Mesal promotor of hind coxa not covering whole mesal portion of intercoxal lamella.

Melissodes (Eumelissodes) agilis Cresson

(Female)

In *metathorax* third pleurotergal muscle overlapping only anterior part of pleurotergal and lateral promotor of middle coxa. Pleurotergal muscle rounded but larger than that of *M. obliqua.* Lateral promotor of middle coxa V-shaped, but inferior arm not so wide (as in Fig 40). *Metathoracic musculature* like that of *M. obliqua.*

Melissodes (Eumelissodes) coloradensis Cresson

(Female)

Mesopleura musculature somewhat similar to that of *M. obliqua* (Fig. 39), but second pleuroaxillary larger than third one, and lateral promotor of middle coxa with smaller inferior arm. *Metathoracic musculature* agrees in detail with that of *M. obliqua.*

Melissodes (Eumelissodes) sp.

(Female. Lawrence, Kansas, September, 1954)

Musculature agrees with description of above species

Melissodes (Melissodes) communis Cresson

(Female)

Mesopleura musculature like that of *M. agilis* (Fig. 40). *Metathoracic musculature* like that of *M. obliqua.*

Melissodes (Melissodes) tepaneca

(Female)

Mesopleura musculature agrees in detail with that of *M. communis* (as in Fig. 40). *Metathoracic musculature* like that of *M. obliqua.*

Florilegus condignus (Cresson)

(Female)

Mesopleura musculature agrees in detail with that of *M. agilis* and *M. communis* (as in Fig. 40). *Metathoracic musculature* like that of *M. obliqua,* but parts of mesal remotor of hind coxa widely separated posteriorly (Fig. 62).

Thygater near *analis* Lepeletier and Serville

(Female. Ciudad del Maiz, S. L. P., Mex., August 22, 1954)

In *mesopleura* third pleuroaxillary muscle overlapping anterior part of pleurotergal. Pleurotergal muscle rounded. Lateral promotor of middle coxa fan-shaped but with a notch (Fig. 41). *Metathoracic musculature* similar to that of *M. obliqua,* but lateral promotor of hind coxa without inner lobe.

Peponapis sp.

(Female. Iguala, Guerrero, Mex., August 8, 1954)

In *mesopleura* third pleuroaxillary muscle overlapping posterior part of second one and anterior part of pleurotergal. Pleurotergal muscle elongated dorsoventrally. Lateral promotor of middle coxa fan-shaped (Fig. 42). *Metathoracic musculature* similar to that of *M. obliqua*, but outer part of mesal remotor of hind coxa arising only on coalesced furcal arms, and on free basal portion of metafurcal arm.

Xenoglossa near *fulva* Smith

(Female. Iguala, Guerrero, Mex., August 8, 1954)

Mesopleura musculature differs from above species as shown in Fig. 43. Lateral promotor of middle coxa with slender inferior arm, superficial fibers of superior arm continuous with fibers of pleurotergal muscle. *Metathoracic musculature* like that of *M. obliqua* but outer part of mesal remotor of hind coxa arising only on coalesced furcal arms, and on free basal portion of metafurcal arm, as is in *Peponapis.*

Xenoglossodes spissa (Cresson)

(Female)

Mesopleura musculature agrees in detail with that of *M. communis* (as in Fig. 40). *Metathoracic musculature* like that of *M. obliqua.*

TRIBE EMPHORINI

In general, the musculature of the species dissected in this tribe is very similar to that of the tribe Eucerini. The only constant feature found in this group and not in the Eucerini, is that the inner part of the mesal remotor of the hind coxa does not have any fibers arising on the mesal portion of the intercoxal lamella. The reason of this is that the mesal promotor of the hind coxa covers entirely the mesal portion of the intercoxal lamella.

Ptilothrix sumichrastii (Cresson)

(Female)

In *mesopleura* third pleuroaxillary muscle overlapping only anterior part of pleurotergal and lateral promotor of middle coxa. Pleurotergal muscle rounded. Lateral promotor of middle coxa V-shaped, with wide inferior arm (Fig. 44). In comparing the *metathoracic musculature* (Fig. 61) with that of *Melissodes obliqua* the following differences (besides the ones mentioned above) are noted: thoracic depressor of hind trochanter on free distal portion of metafurcal arm and on lateral half of coalesced furcal arms; lateral promotor of hind coxa not divided by a notch.

Diadasia near *diminuta* (Cresson)

(Female. Carmen, Hidalgo, Mex., July 28, 1954)

Mesopleura musculature somewhat similar to that of *Ptilothrix sumichrastii* (see Fig. 44 and 45). *Metathoracic* musculature differs from that of *Melissodes obliqua,* besides ones mentioned above, in that lateral promotor of hind coxa is not divided by a notch.

Diadasia enevata (Cresson)

(Female)

In *mesopleura* third pleuroaxillary muscle overlapping part of second one and part of pleurotergal and lateral promotor of middle coxa. Pleurotergal muscle rounded. Lateral promotor of middle coxa V-shaped with very wide inferior arm (Fig. 46). The *metathoracic musculature* differs from the description of *Melissodes obliqua,* besides the ones mentioned above, as follows: ventral lateromotor of abdomen on posterior ridge of verticle plate of metasternum; lateral promotor of hind coxa not divided by a notch.

Melitoma euglossoides Lepeletier and Serville

(Female)

In *mesopleura* pleuroaxillary muscles like that of *Diadasia* (near *diminuta*) (Fig. 45). Pleurotergal a rather rounded muscle. Lateral promotor of middle coxa fan-shaped but inferior fibers shorter and separated by a notch from superior fibers (Fig. 47). In comparing the *metathoracic* musculature with that of *Melissodes obliqua* the following points (besides the ones mentioned above) are noted: outer part of mesal remotor of hind coxa arising on small mesal section of free distal portion of metafurcal arm, on coalesced furcal arms, and on free basal portion of metafurcal arm; lateral promotor of hind coxa not divided by a notch, as all other forms in this tribe.

TRIBE ANTHOPHORINI

Anthophora californica texana Cresson

(Female)

In *mesopleura* third pleuroaxillary a large muscle, overlapping more than half of second one anteriorly, and small section of pleurotergal posteriorly. Pleurotergal muscle large and dorsoventrally elongated. Lateral promotor of middle coxa as in *Melitoma englossoides,* fan-shaped but with inferior fibers shorter than superior ones (Fig. 48). In metathorax median depressor of abdomen a band-shaped muscle arising on coalesced furcal arms and few fibers on mesofurcal bridge. Ventral lateromotor of abdomen on anterior ridge of vertical plate of metasternum. Mesal remotor of hind coxa not divided (Fig. 63), originating on coalesced furcal arms and on free basal portion of metafurcal arm. Thoracic depressor of hind trochanter on free distal portion of metafurcal arm, occupying entire posterior surface of dorsal process, and on coalesced furcal arms. Lateral promotor of hind coxa with outer and inner lobes separated by a notch, as is in *Melissodes* and some *Exomalopsis.* Mesal promotor of hind coxa almost covering whole mesal portion of intercoxal lamella.

Anthopora (near *californica*) sp.

(Female. Ixmiquilpan, Mex., July 29, 1954)

The description of this species agrees with the previous one.

TRIBE HEMISIINI

Centris near *agilis* Smith

(Female. Taxco, Guerrero, Mex., August 8, 1954)

In *mesopleura* third pleuroaxillary muscle overlapping only anterior part of pleurotergal. Pleurotergal muscle dorsoventrally elongated. Lateral promotor of hind coxa fan-shaped (Fig. 49). In *metathorax* median depressor of abdomen on coalesced furcal arms. Ventral lateromotor of abdomen a small muscle arising on posterior ridge of vertical plate of metasternum. Mesal remotor of hind coxa divided, (Fig. 64) outer part on coalesced furcal arms and on free basal portion of metafurcal arm, inner part on base of metafurcal arm and on anterior ridge of mesal portion of intercoxal lamella. Thoracic depressor of hind trochanter on free distal portion of metafurcal arm, occupying entire posterior surface of dorsal process, and on coalesced furcal arms (as is in *Anthophora californica*). Lateral promotor of hind coxa lobed. Mesal promotor of hind coxa not covering whole mesal portion of intercoxal lamella.

Centris lanosa (Cresson)

(Female)

This species agrees with the description of the above species except that some fibers of the outer part of the median remotor of the hind coxa are fused with the thoracic depressor of the hind trochanter.

Epicharis sp.

(Female. Cuernavaca, Morelos, Mex., August 4, 1954)

In *mesopleura* third pleuroaxillary muscle overlapping anterior parts of pleurotergal and lateral promotor of middle coxa. Pleurotergal muscle rounded. Lateral promotor of middle coxa V-shaped (Fig. 50). In *metathorax* median depressor of abdomen on free distal portion of metafurcal arm and on coalesced furcal arms. Ventral lateromotor of abdomen a rather large muscle, arising along ridge of vertical plate of metasternum, and some fibers on free basal portion of metafurcal arm. Mesal remotor of hind coxa not divided, but partially fused anteriorly with thoracic depressor of hind trochanter (Fig. 66); it originates on coalesced furcal arms, on free basal portion of metafurcal arm, and some fibers on anterior ridge of mesal portion of intercoxal lamella. Thoracic depressor of hind trochanter on free distal portion of metafurcal arm and on lateral part of coalesced furcal arms. Lateral promotor of hind coxa a large muscle (Fig. 65), with outer and inner lobes separated by a notch, inner lobe large. Mesal promotor of hind coxa small and arising on posterior part of vertical plate of metasternum, some fibers on mesal portion of intercoxal lamella (Fig. 65).

Subfamily XYLOCOPINAE

TRIBE XYLOCOPINI

Xylocopa fimbriata Fabricius

(Female)

In *mesopleura* third pleuroaxillary muscle overlapping almost completely second one. Anterior part of pleurotergal and lateral promotor of middle coxa overlapped by second and third pleuroaxillary muscles. Pleurotergal muscle rounded and above level of inferior end of third pleuroaxillary. Lateral promotor of middle coxa V-shaped (Fig. 51). In *metathorax* median depressor of abdomen on free distal portion of metafurcal arm and on coalesced furcal arms. Ventral lateromotor of abdomen originating along ridge of vertical plate of metasternum. Mesal remotor of hind coxa not divided and arising on coalesced furcal arms, on free basal portion of metafurcal arm, and some fibers on anterior ridge of mesal portion of intercoxal lamella; its insertion covers most of posterior basal margin of hind coxa (Fig. 67). Thoracic depressor of hind trochanter on free distal portion of metafurcal arm and on coalesced furcal arms. Lateral promotor of hind coxa with outer and inner lobes separated by a notch. Mesal promotor of hind coxa not covering whole mesal portion of intercoxal lamella.

Xylocopa brasilianorum Linnaeus

(Female)

The description of this species agrees with that of the above species.

TRIBE CERATININI

Ceratina (*Zadontomerus*) *ignara* Cresson

(Female)

In *mesopleura* third pleuroaxillary muscle overlapping part of second one and part of pleurotergal and lateral promotor of middle coxa. Pleurotergal muscle fan-shaped and above level of inferior end of third pleuroaxillary. Lateral promotor V-shaped (Fig. 52). In *metathorax* median depressor of abdomen a ribbonlike muscle (fused posteriorly to its counter part (Fig. 69), arising on coalesced furcal arms, some fibers on mesofurcal bridge. Ventral lateromotor of abdomen originating along ridge of vertical plate of metasternum. Mesal remotor of hind coxa a ribbonlike muscle (Fig. 68) arising only on free basal portion of metafurcal arm. Thoracic depressor of hind trochanter on free distal portion, occupying entire posterior surface of dorsal process, and on coalesced furcal arms. Lateral promotor of hind coxa with small inner lobe. Mesal promotor of hind coxa not covering whole mesal portion of intercoxal lamella.

Ceratina (*Zadontomerus*) *dupla* Say

(Female)

This species agrees with the description of *C. ignara*.

Subfamily APINAE

TRIBE EUGLOSSINI

Euglossa (*Euglossa*) sp.

(Female. Zimapan, Hidalgo, Mex., July 27, 1954)

In *mesopleura* third pleuroaxillary muscle overlapping more than half of second one. Second and third pleuroaxillary overlapping anterior part of pleurotergal and lateral promotor of middle coxa. Pleurotergal a rather rounded and large muscle. Lateral promotor of middle coxa V-shaped (Fig. 53). In *metathorax* median depressor of abdomen on free distal portion of metafurcal arm and on coalesced furcal arms. Ventral lateromotor of abdomen arising along ridge of vertical plate of metasternum. Mesal remotor of hind coxa not divided (Fig. 71) and somewhat fused anteriorly with thoracic depressor of hind trochanter, originating on coalesced furcal arms, on free basal portion of metafurcal arm, and on anterior ridge of mesal portion of intercoxal lamella. Thoracic depressor of hind trochanter on free distal portion of metafurcal arm and on coalesced furcal arms. Lateral promotor of hind coxa lobed. Mesal promotor of hind coxa not covering whole mesal portion of intercoxal lamella.

Eulaema mussitans (Fabricius)?

(Female)

Musculature like that of *Euglossa.*

TRIBE BOMBINI

The species dissected in this group exhibit similar musculature with that of the tribe Englossini.

Bombus (*Fervidobombus*) *medius* Cresson

(Female)

Mesopleura musculature differs from that of *Euglossa* as shown in Fig. 54. In comparing the *metathoracic musculature* with that of *Euglossa* the following differences are noted: mesal remotor of hind coxa with narrower insertion on posterior basal margin of hind coxa, and entirely fused with anterior part of thoracic depressor of hind trochanter. (Fig. 70).

Bombus (*Fraternobombus*) *fraternus* Smith

(Male and female)

Musculature like that of *B. medius.*

Bombus (*Pyrobombus*) *ephippiatus* Say

(Worker and queen)

Musculature as in *B. medius* but mesal remotor of hind coxa not so fused with thoracic depressor of hind trochanter.

Bombus sp.

(Female. Zimapan, Hidalgo, Mex., July 27, 1954)

Musculature of this species agrees with that of *B. medius,* but mesal remotor of hind coxa not so fused with thoracic depressor of hind trochanter, as is in *B. ephippiatus.*

Bombus sp.

(Female. Lawrence, Kan., June, 1953)

Musculature like that of *B. medius.*

TRIBE MELIPONINI

All the species dissected exhibit very homogeneous type of musculature. The species dissected are as follows: *Melipona beechei* Bennett (female), *Trigona (Partamona) testacea* (Klug) female, *Trigona (Cephalotrigona) capitata* Smith female, *Trigona (Tetragona) jaty* Smith (female), *Lestrimelitta* (female Bolivia).

Melipona beechei Bennett

In *mesopleura* second and third pleuroaxillary muscles overlapping anterior part of pleurotergal. Pleurotergal a large muscle shaped as shown in Fig. 55. Lateral promotor of middle coxa fan-shaped. In *metathorax* (Fig. 72) median depressor of abdomen a ribbonlike muscle originating on mesal half of coalesced furcal arms. Ventral lateromotor of abdomen small muscle arising on free basal portion of metafurcal arm. Mesal remotor of hind coxa on mesal half of coalesced furcal arms and on free basal portion of metafurcal arm, some fibers are fused anteriorly with thoracic depressor of hind trochanter. Thoracic depressor of hind trochanter on free distal portion of metafurcal arm and on lateral half of coalesced furcal arms. Lateral promotor of hind coxa lobed. Mesal promotor of hind coxa covering whole mesal portion of intercoxal lamella.

TRIBE APINI

Apis mellifica Linnaeus

(Male)

In *mesopleura* third pleuroaxillary overlapping posterior part of second one and anterior part of pleurotergal. Pleurotergal muscle dorsoventrally elongated. Lateral promotor of middle coxa a slender muscle, (only superior arm) on pleural apophysis (Fig. 56). In *metathorax* median depressor of abdomen ribbonlike, on free basal portion of metafurcal arm and on mesal section of coalesced furcal arms. Ventral lateromotor of abdomen on anterior ridge of vertical plate of metasternum. Mesal remotor of hind coxa on free basal portion of metafurcal arm, some fibers on coalesced furcal arms. Thoracic depressor of hind trochanter on lateral half of coalesced furcal arms, some fibers on free distal portion of metafurcal arm. Lateral promotor of hind coxa a thin muscle almost covering mesal portion of intercoxal lamella.

Among the thirty specimens dissected one male was found with the lateral promotor of middle coxa possessing a small inferior arm (Fig. 57).

Apis mellifica L.

(Worker)

The worker differs from that of the male in the mesopleura musculature (Fig. 58). Second and third pleuroaxillary muscles overlapping anterior part of pleurotergal. Pleurotergal muscle wider. Lateral promotor of middle coxa V-shaped.

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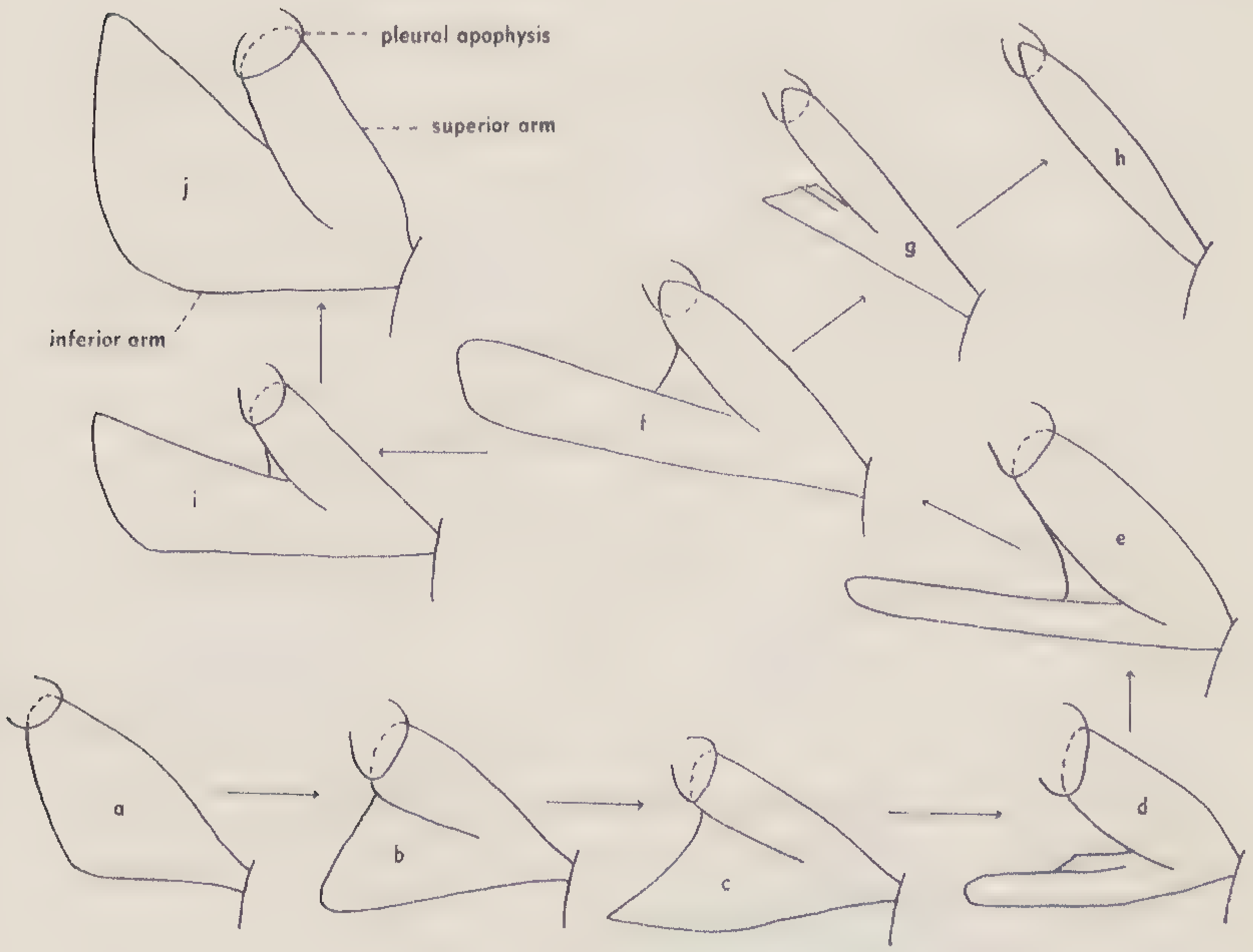
FIG. 1. Trends of specialization of the lateral promotor of the middle coxa.

a—as in *Colletes* sp. (female).
b—as in *Pseudopanurgus* sp. (female).
c—as in *Neopasites* sp. (female).
d—as in *Dianthidium sayi* (female).
e—as in *Xenoglossa* sp. near *fulva* (female).
f—as in *Apis mellifica* (worker).
g—as in *Apis mellifica* (male, see page 469).
h—as in *Apis mellifica* (male).
i—as in *Diadasia* near *diminuta* (female).
j—as in *Melissodes obliqua* (female).

FIG. 2. Trends of specialization of the lateral promotor of the hind coxa.

a—as in *Megachile* sp. (female).
b—as in *Heriades variolosa purpurascens* (male).
c—as in *Ashmeadiella opuntiae* (male).
d—as in *Andrena argemonis* (male).
e—as in *Protoxaea nigerrima* (female).
f—as in *Exomalopsis snowi* (female).
g—as in *Epicharis* sp. (female).
h—as in *Apis mellifica* (worker).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superior arm
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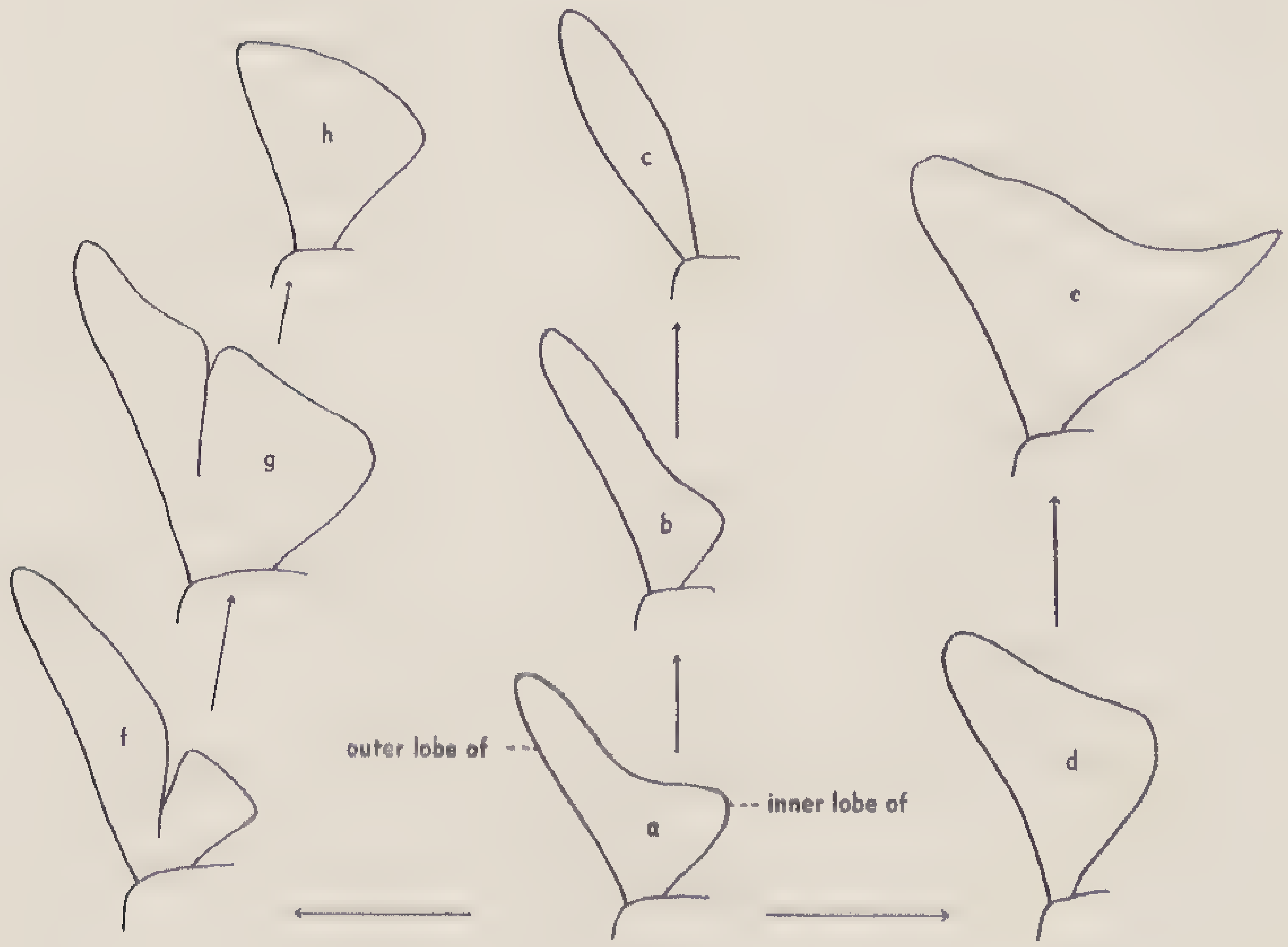
1


h
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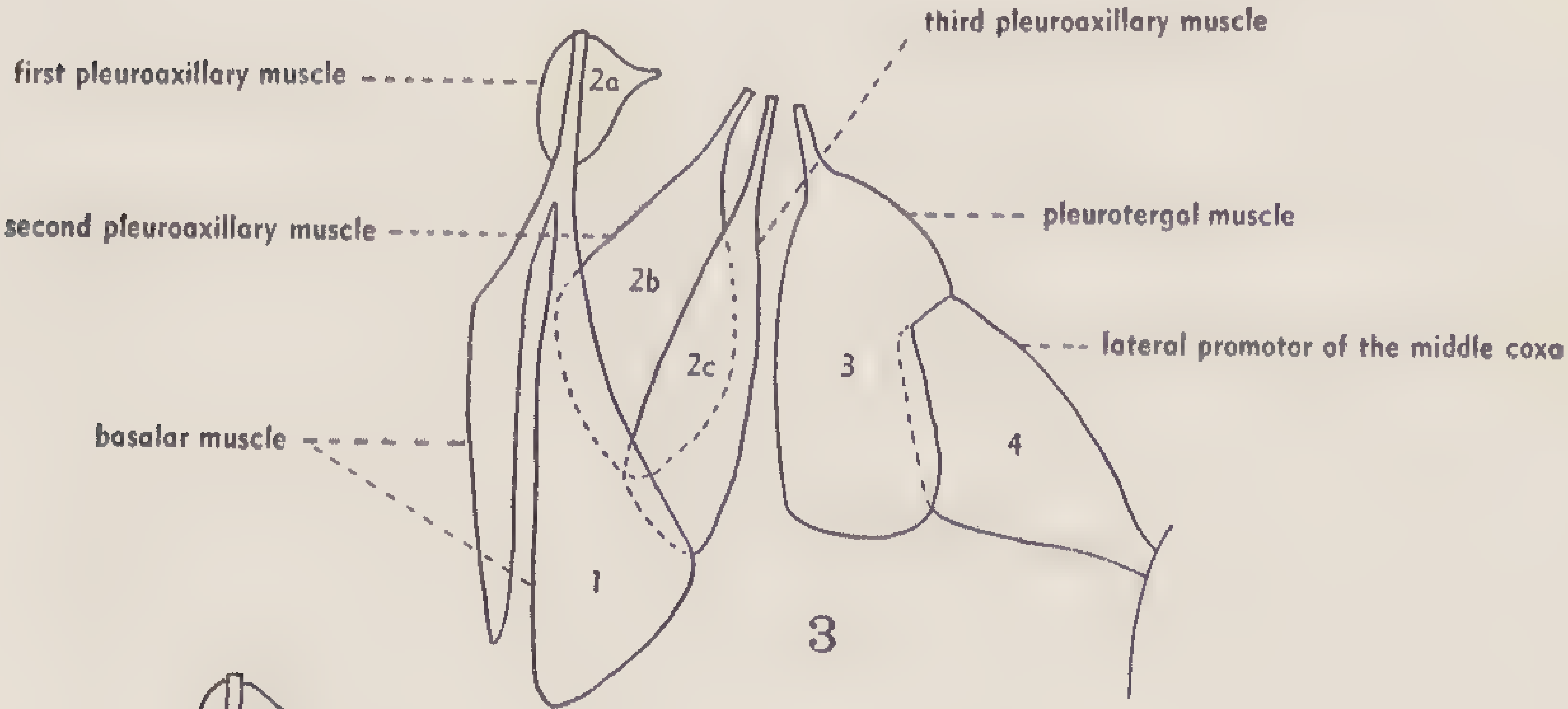
outer lobe of
a
inner lobe of
d

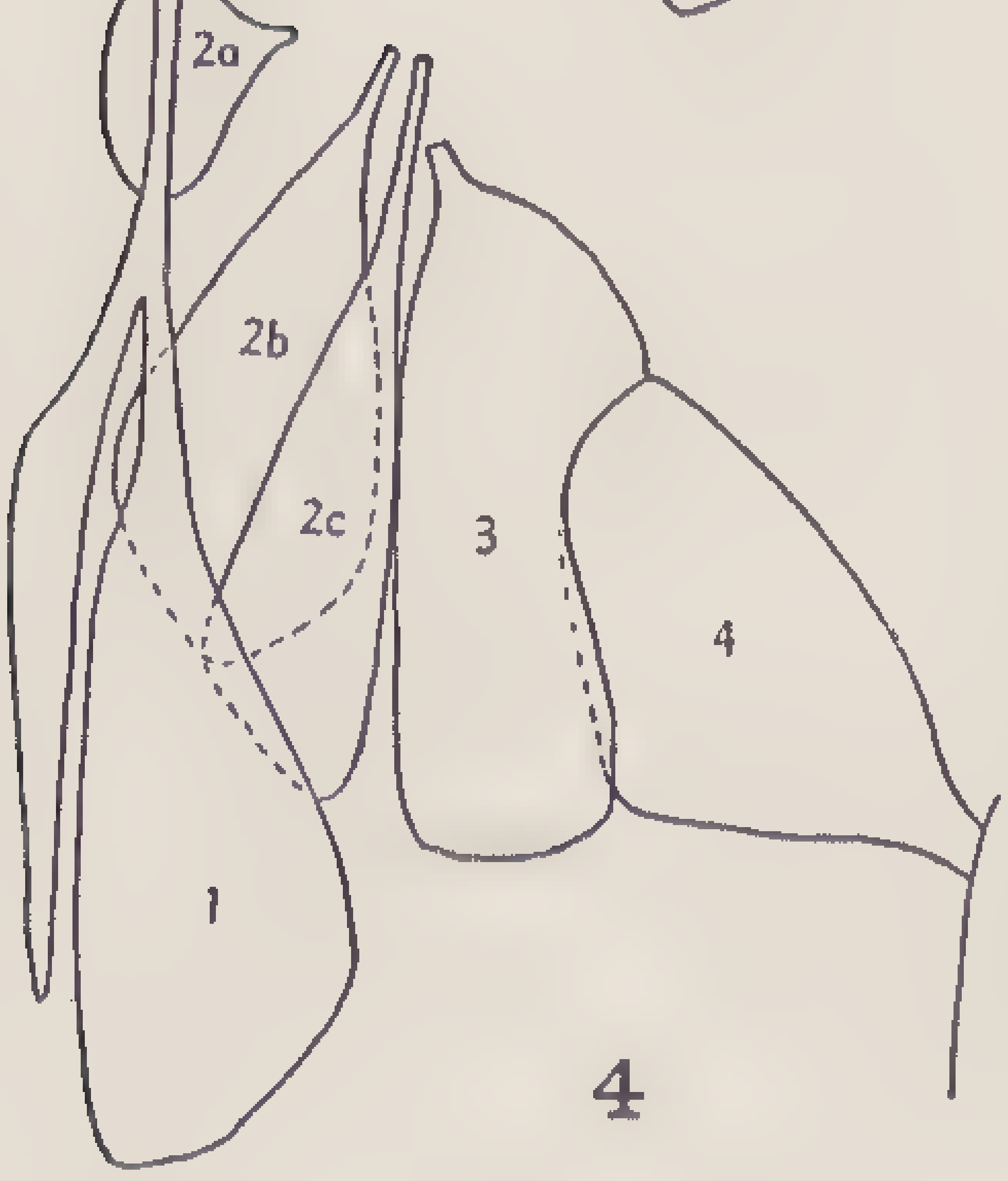
2

MESOPLEURAL MUSCALATURE (Right Side)

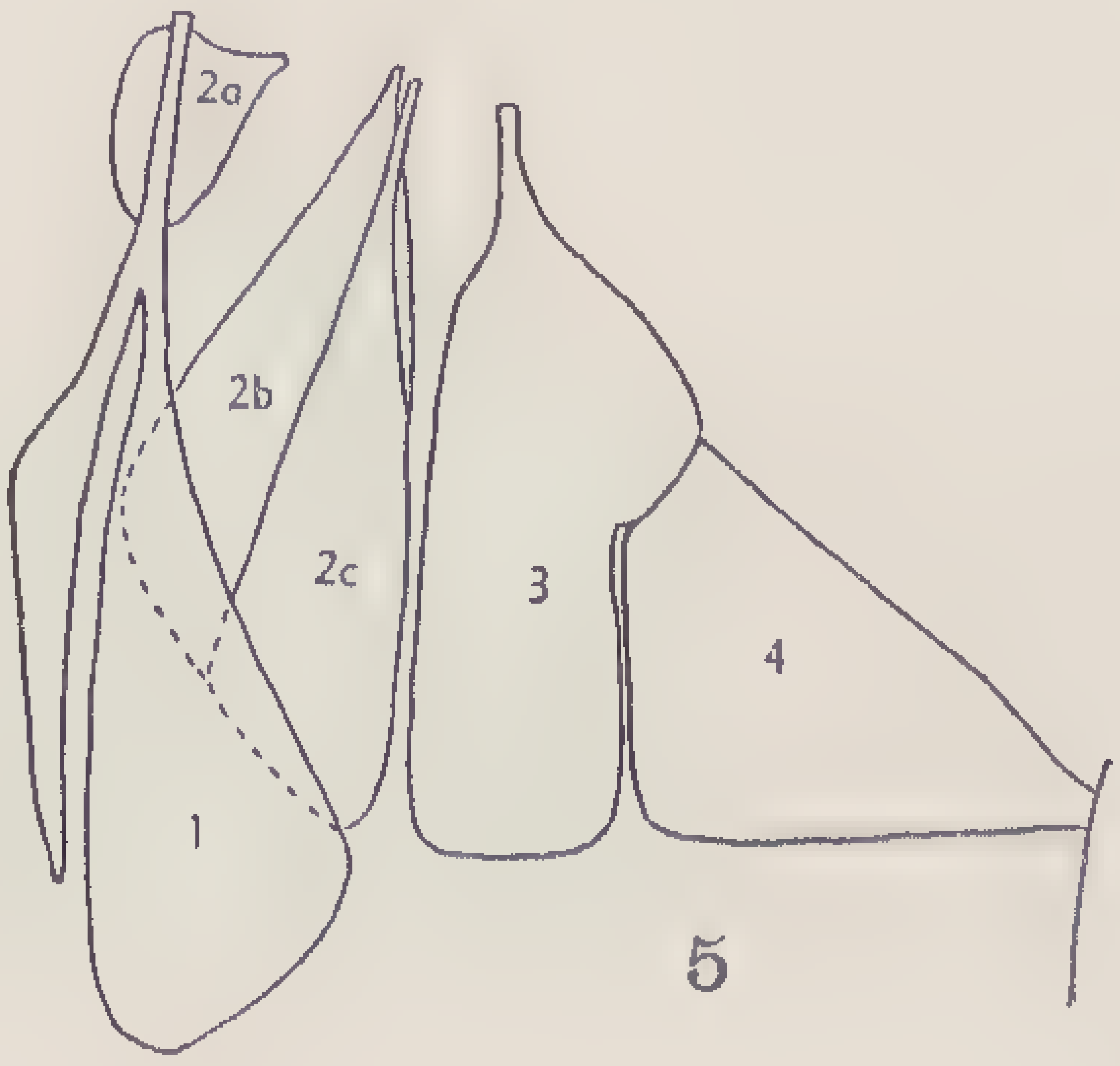
FIG. 3. *Colletes* sp. (female).
FIG. 4. *Halictus ligatus* (female).
FIG. 5. *Dufourea marginata* (female).
FIG. 6. *Nomia nortoni* (male).
FIG. 7. *Nomia micheneri* (male) 1, 2a muscles omitted.


first pleuroaxillary muscle
second pleuroaxillary muscle
basalar muscle
third pleuroaxillary muscle
pleurotergal muscle
lateral promotor of the middle coxa
2a
2b
2c
3
4
1

3


2a
2b
2c
3
4
1

4


2a
2b
2c
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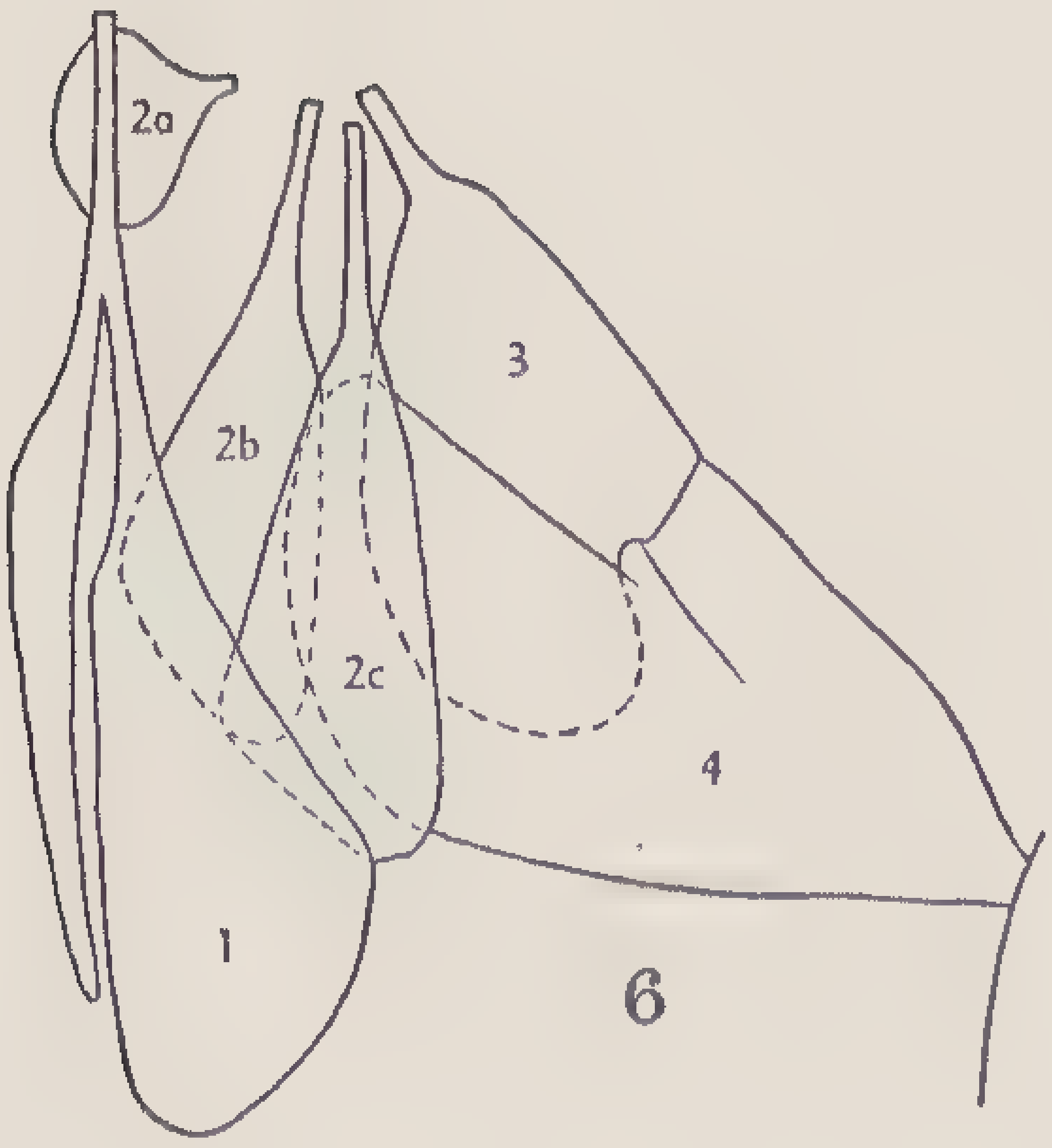
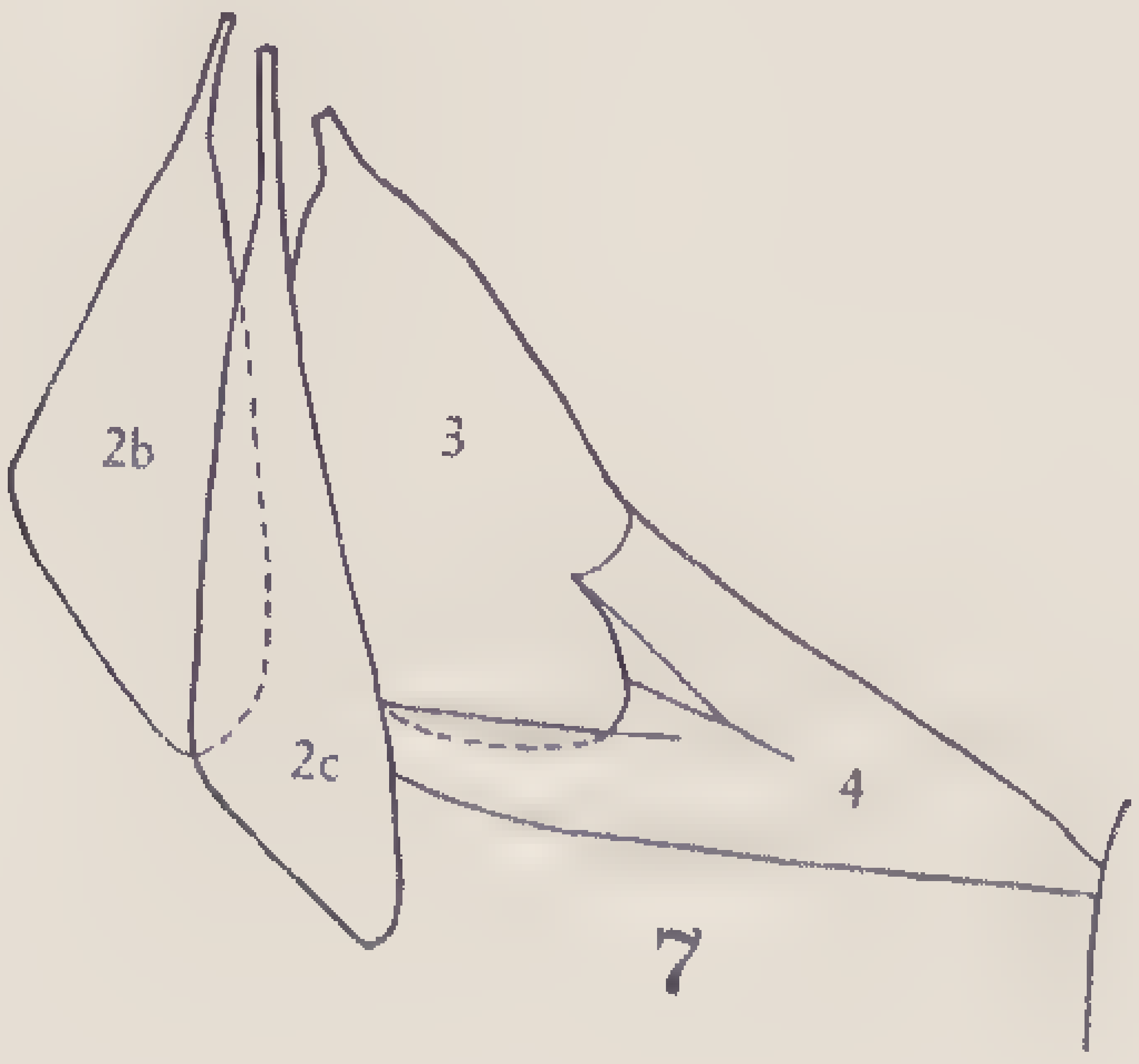
1

5


2a
3
2b
2c
4
1

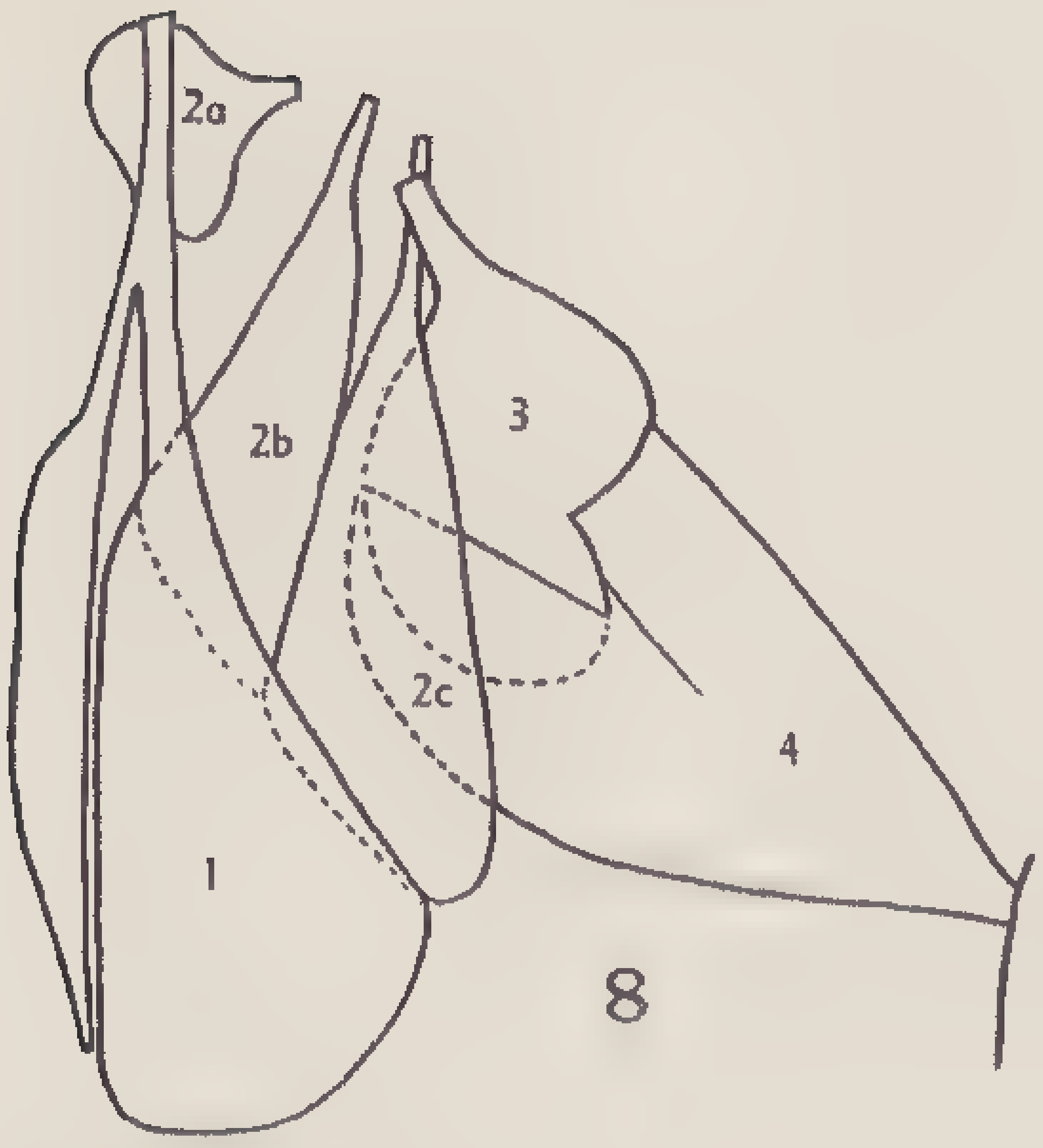
6


2b
3
2c
4

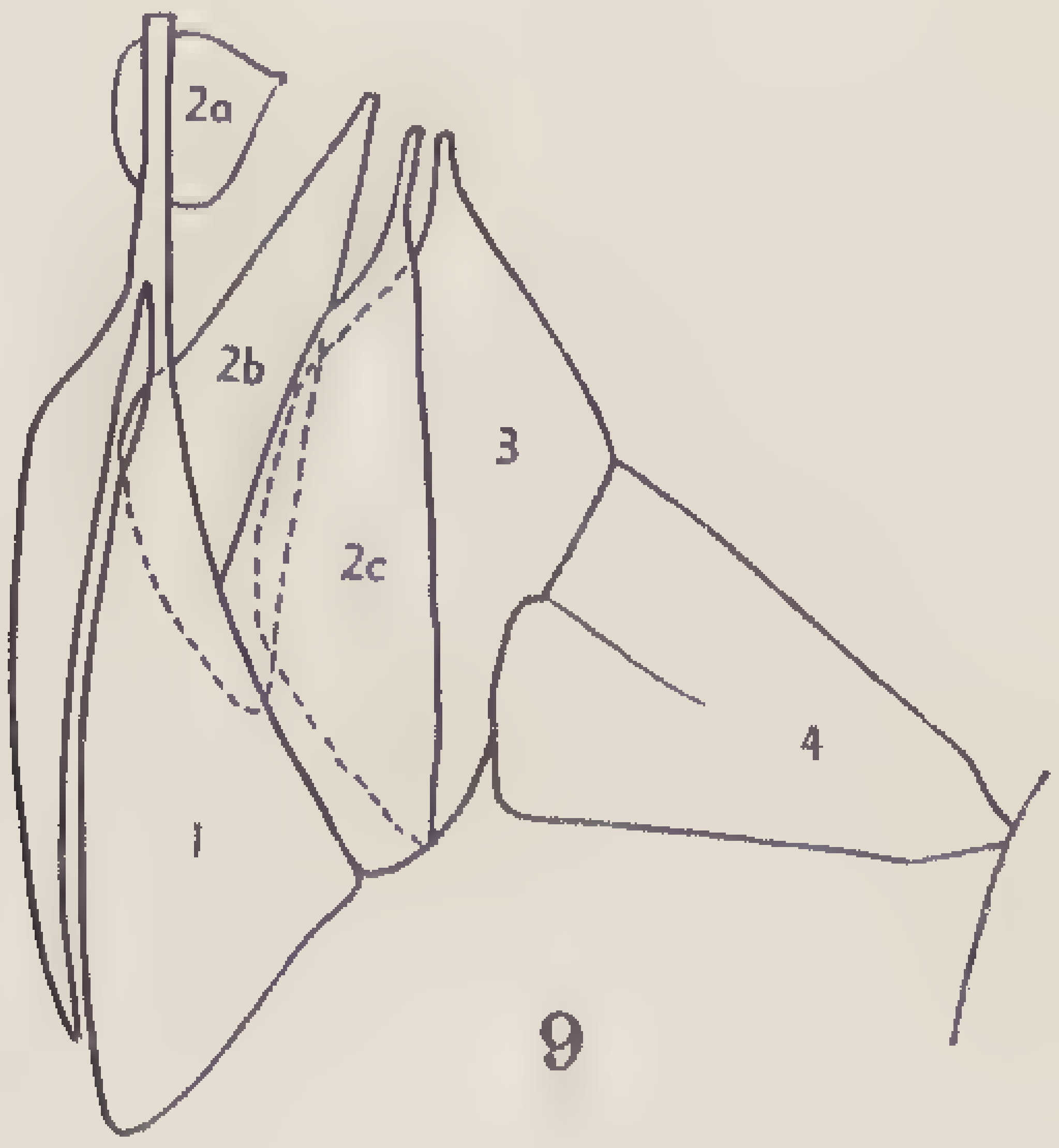
7

MESOPLEURAL MUSCULATURE (Right Side)

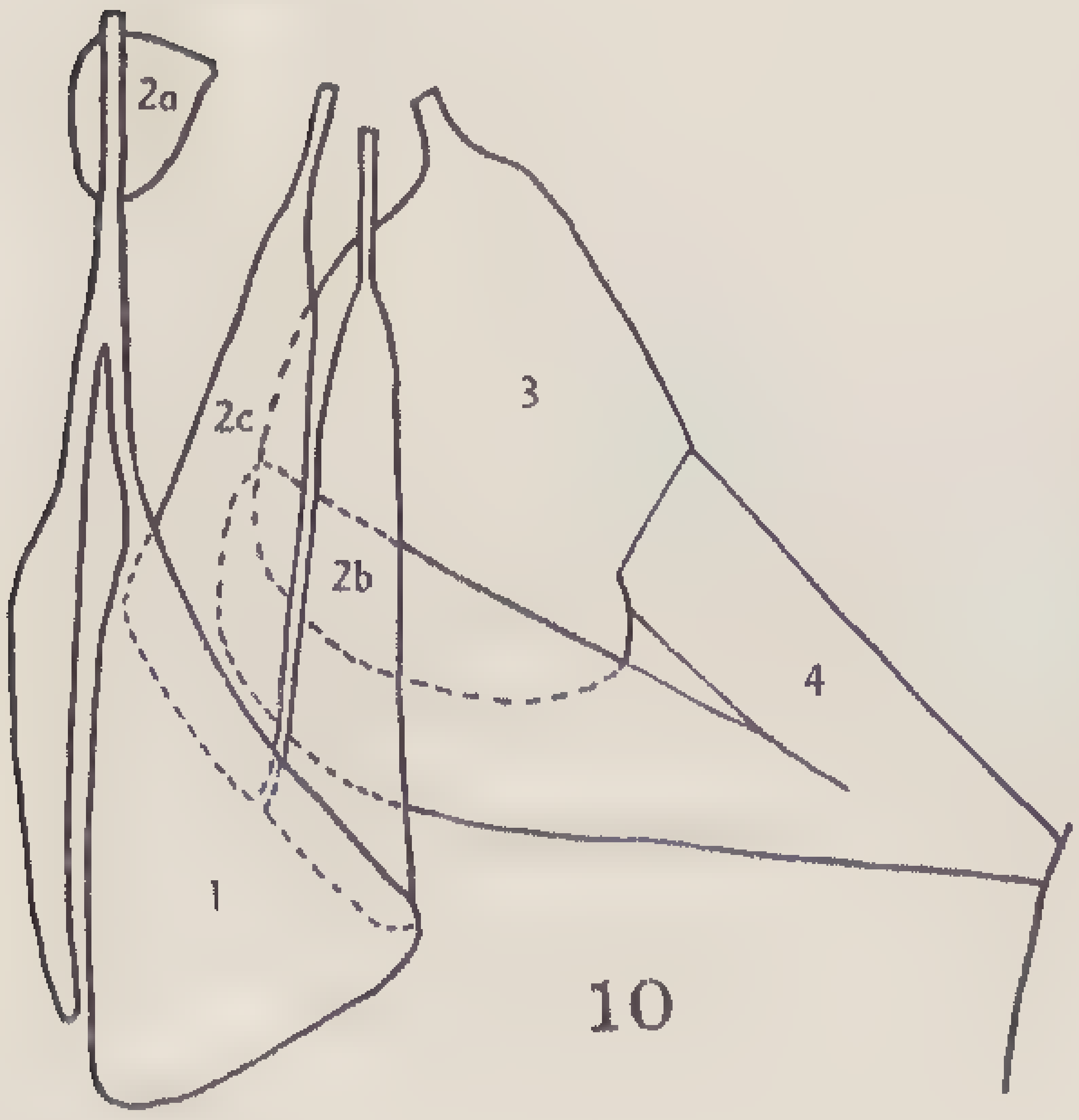
FIG. 8. *Nomia (ieunomia)* sp. (female).
FIG. 9. *Andrena argemonis* (male).
FIG. 10. *Perdita* sp. (female).
FIG. 11. *Pseudopanurgus* sp. (female).
FIG. 12. *Calliopsis* near *andreniformis* (female).
FIG. 13. *Protoxaea nigerrima* (female).


2a
2b
3
2c
4
1

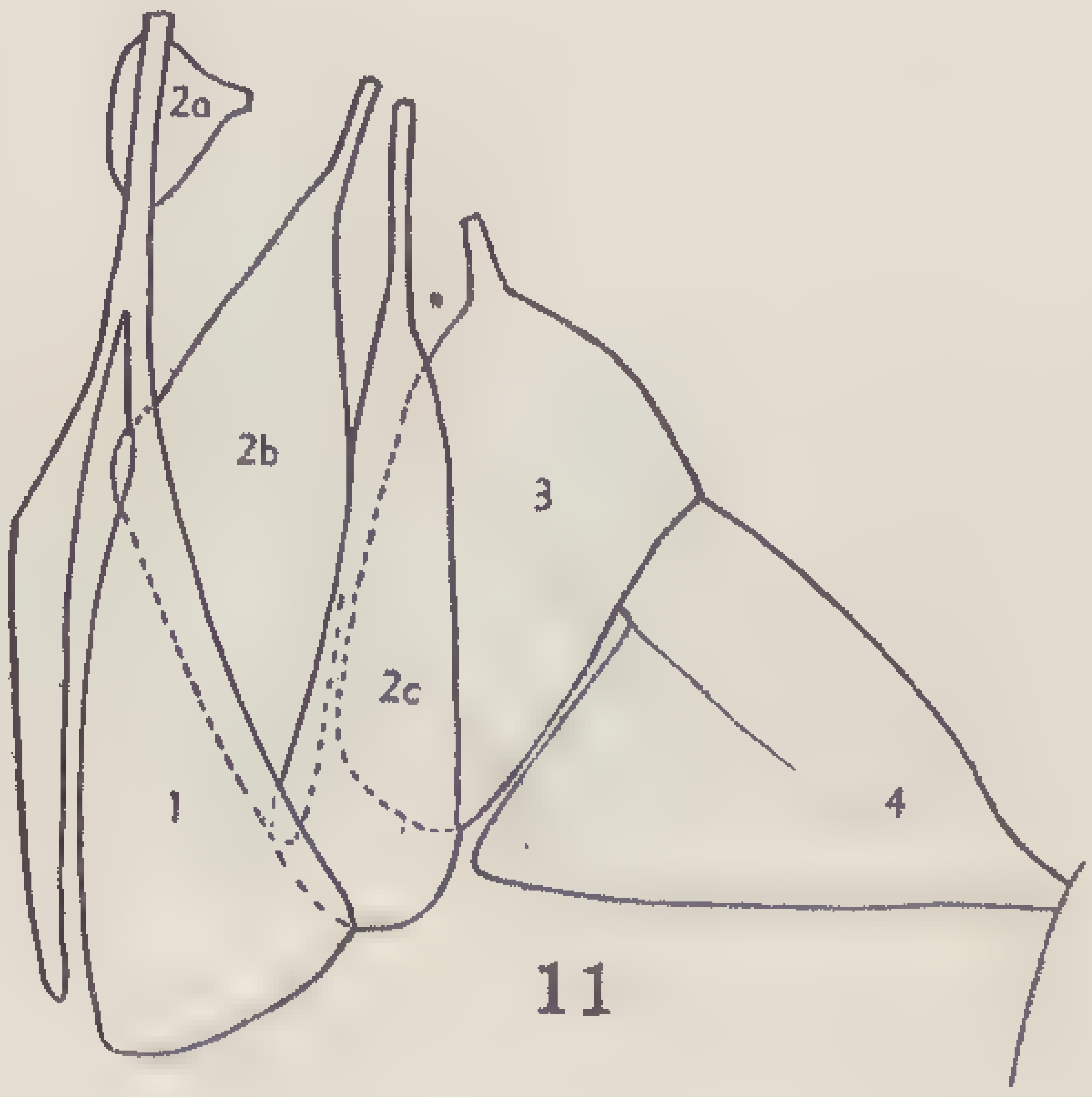
8


2a
2b
3
2c
4
1

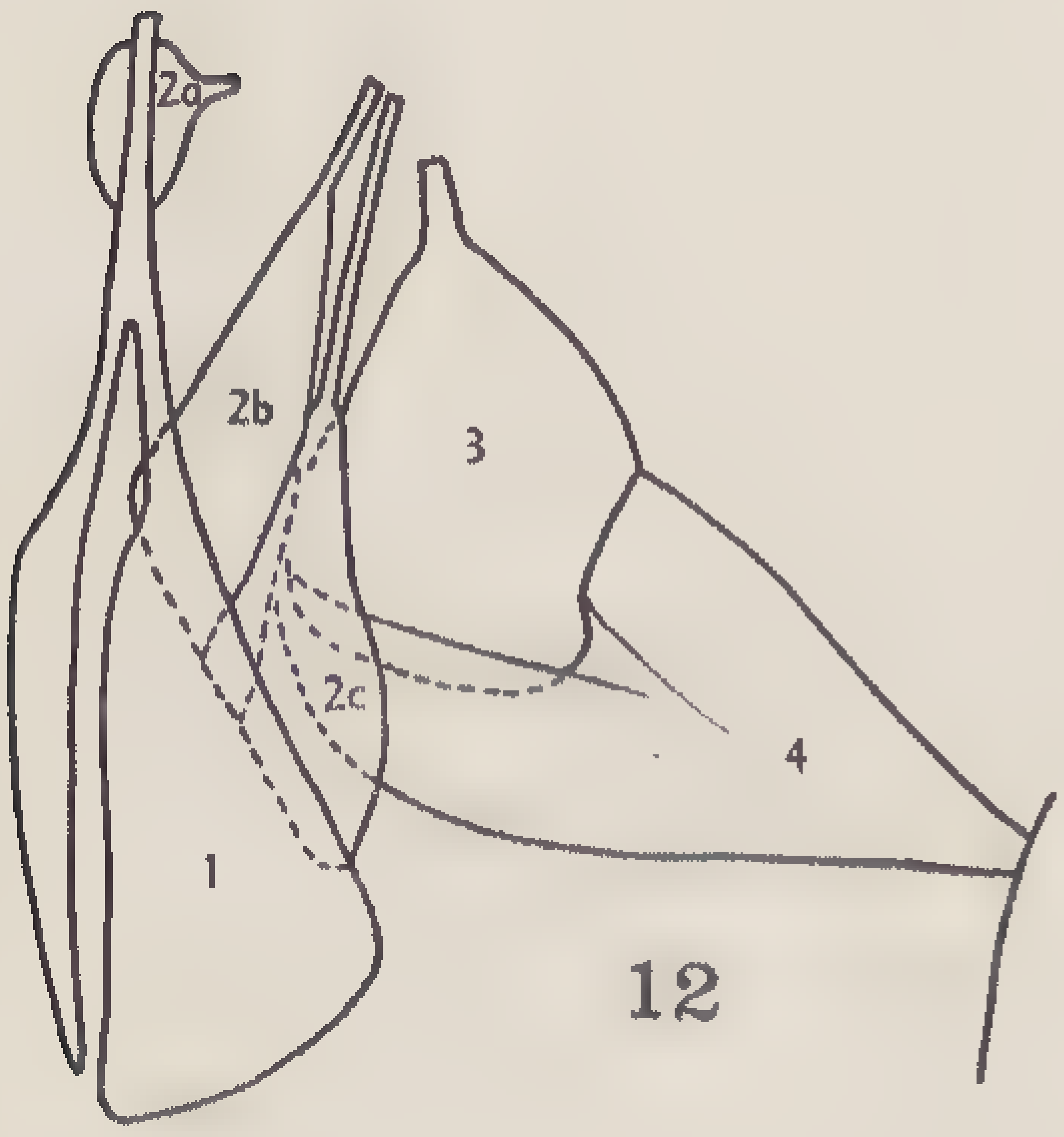
9


2a
3
2c
2b
4
1

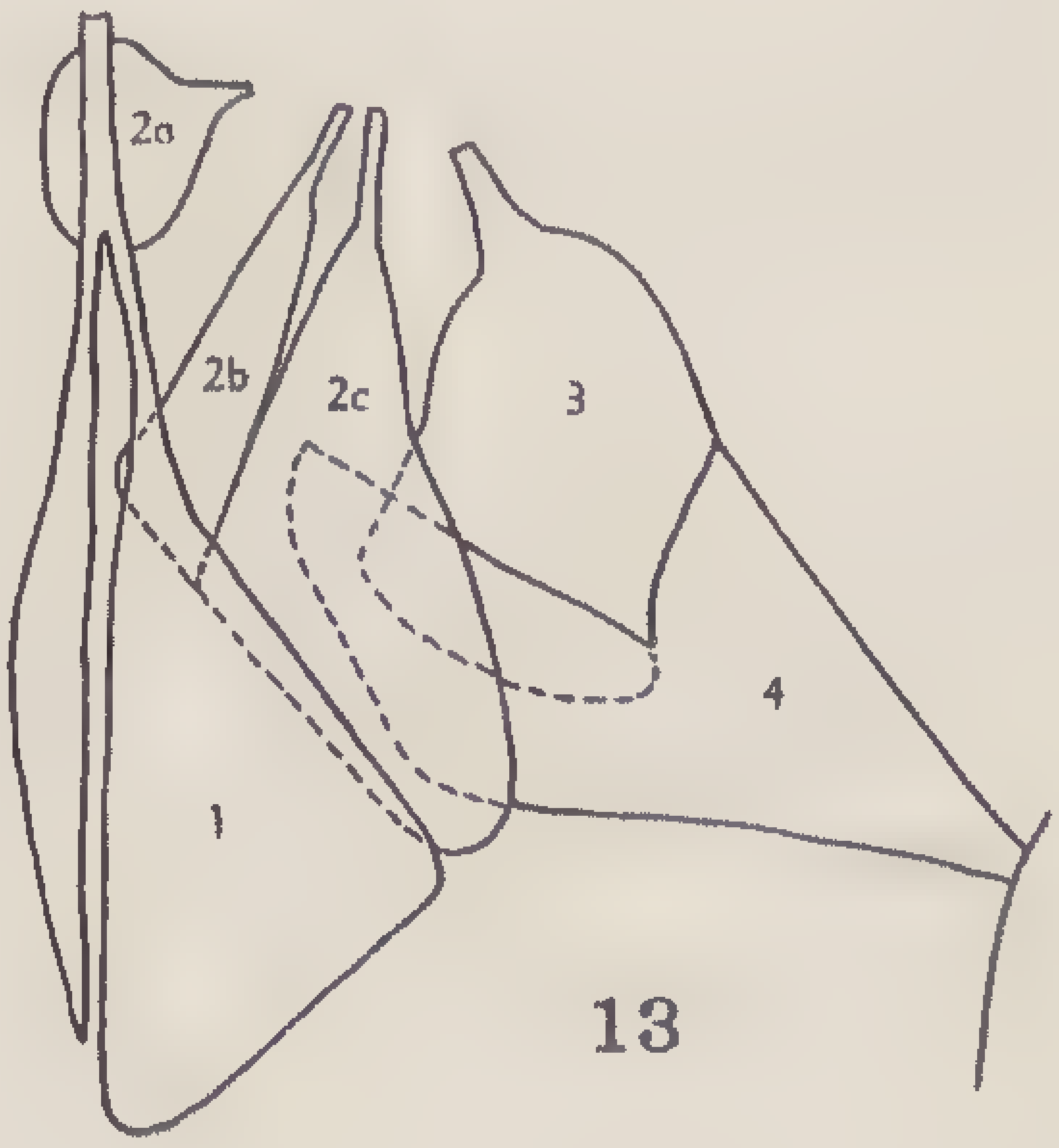
10


2a
2b
3
2c
1
4

11


2a
2b
3
2c
4
1

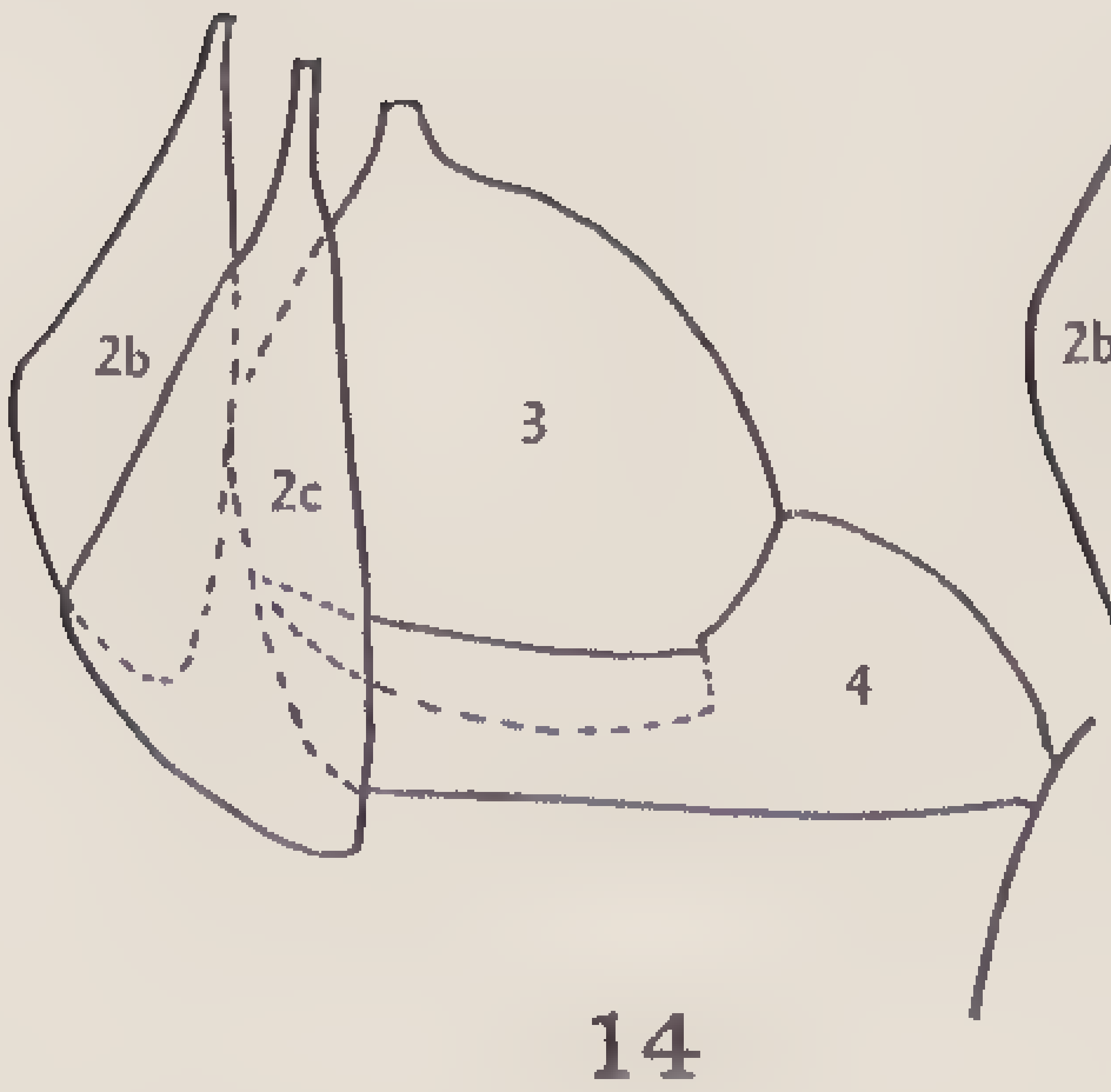
12


2a
2b
2c
3
4
1

13

MESOPLEURAL MUSCULATURE (Right Side)

FIG. 14. *Megachile* sp. (female) 1, 2a muscles omitted.
FIG. 15. *Coelioxys* sp. (female) 1, 2a muscles omitted.
FIG. 16. *Ashmeadiella opuntiae* (male) 1, 2a muscles omitted.
FIG. 17. *Heriades variolosa purpurascens* (male).
FIG. 18. *Anthidium maculosum* (female).
FIG. 19. *Dianthidium sayi* (female).
FIG. 20. *Lithurge* sp. (female).



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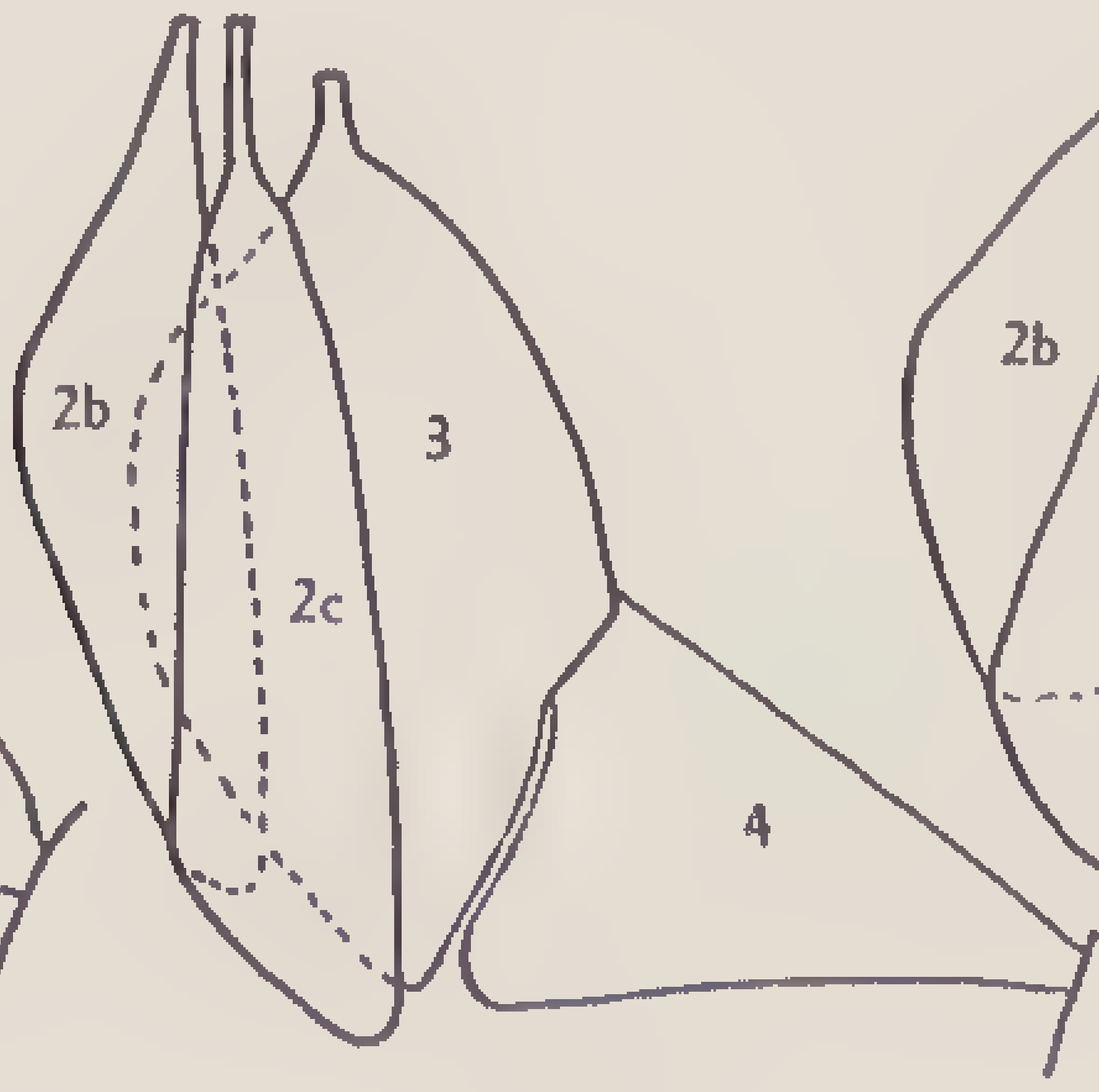

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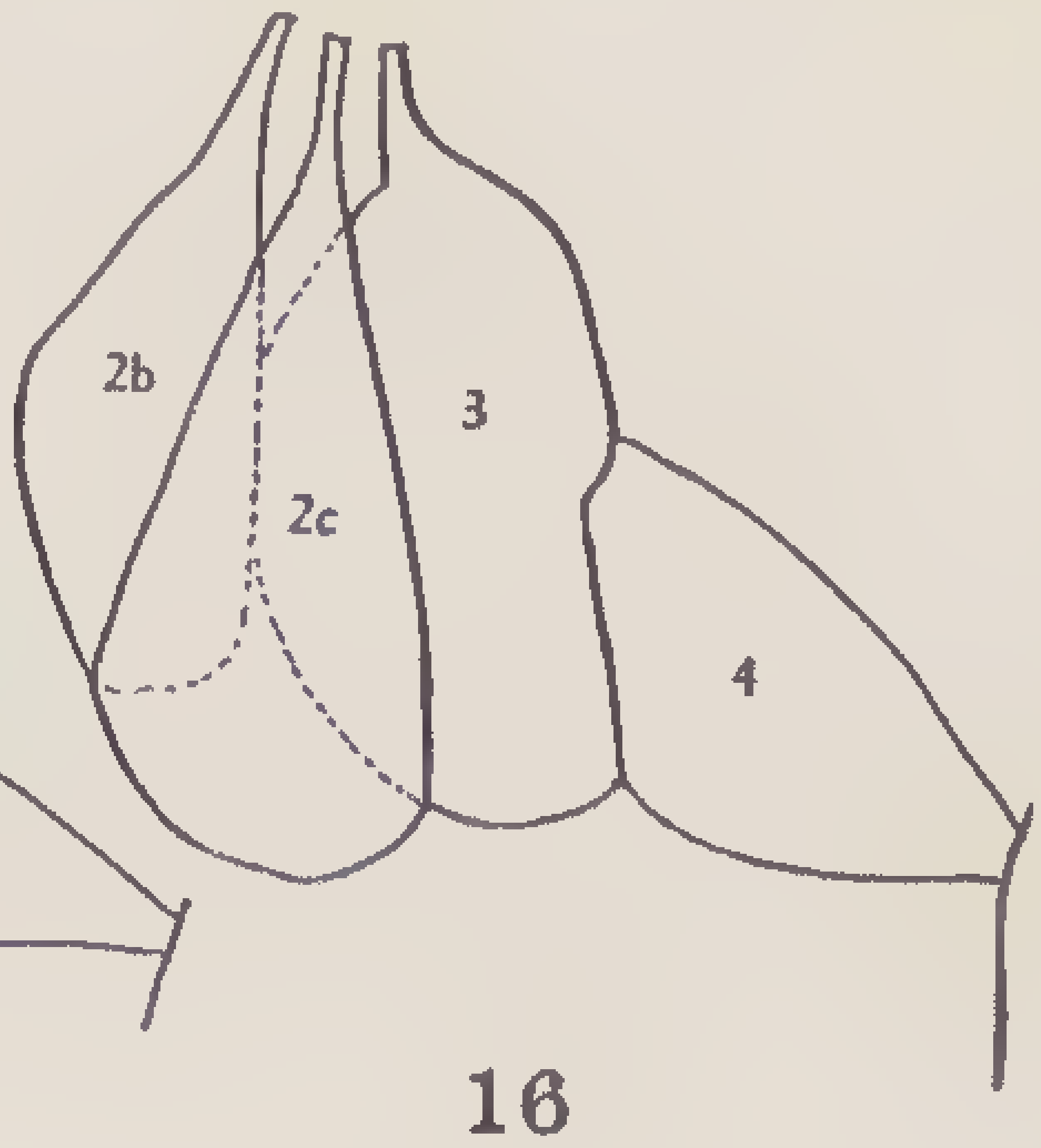

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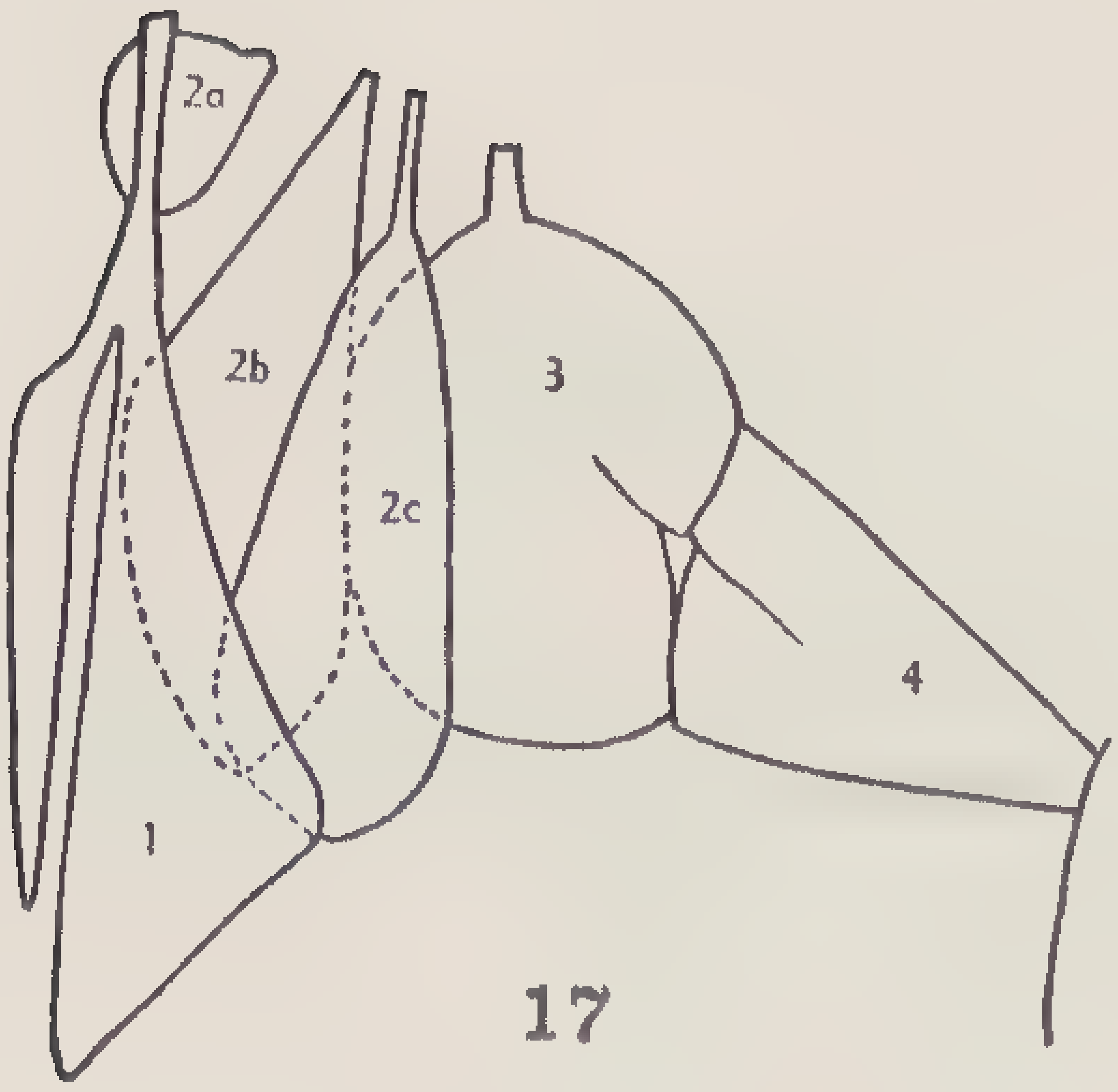

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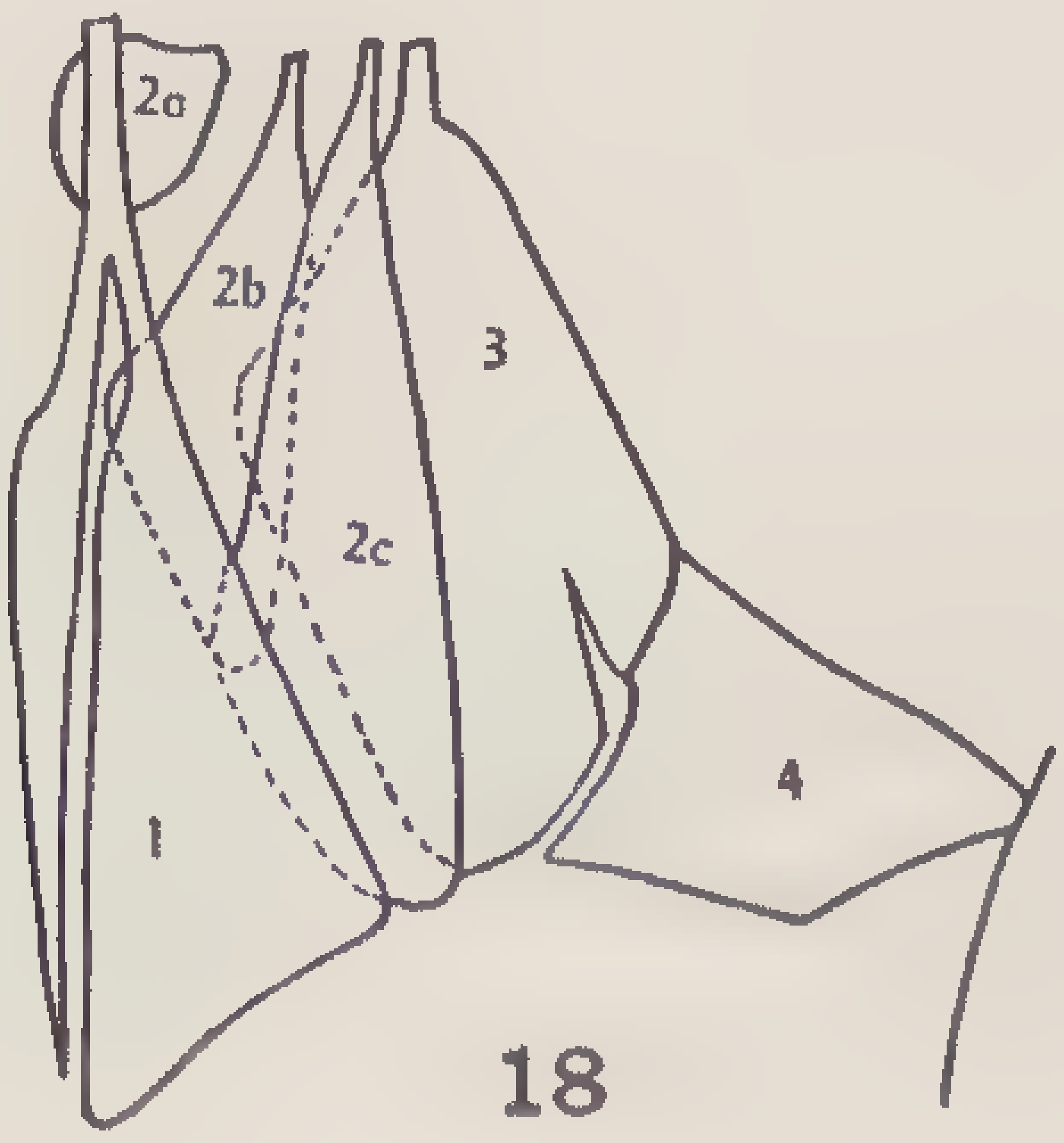

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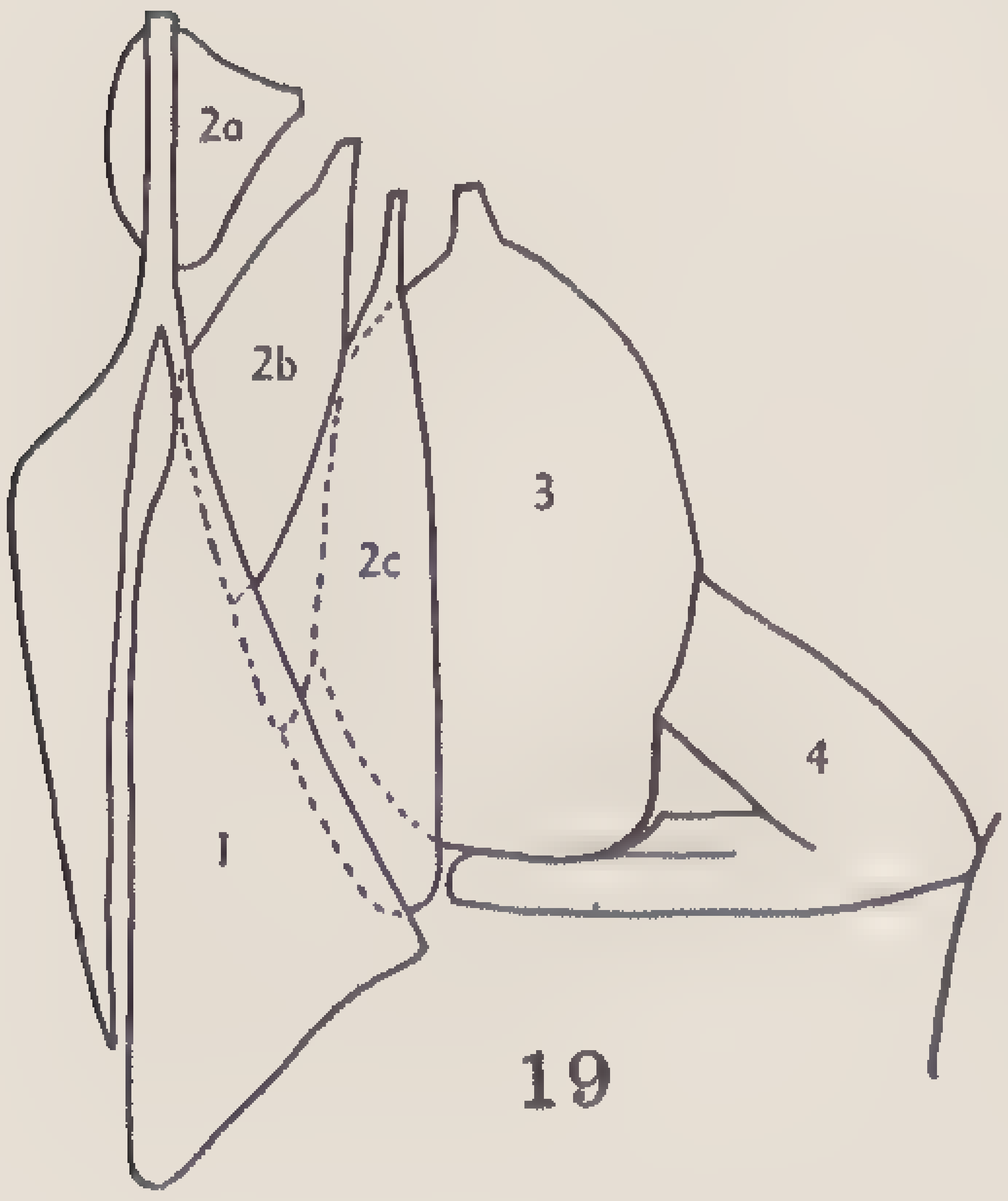
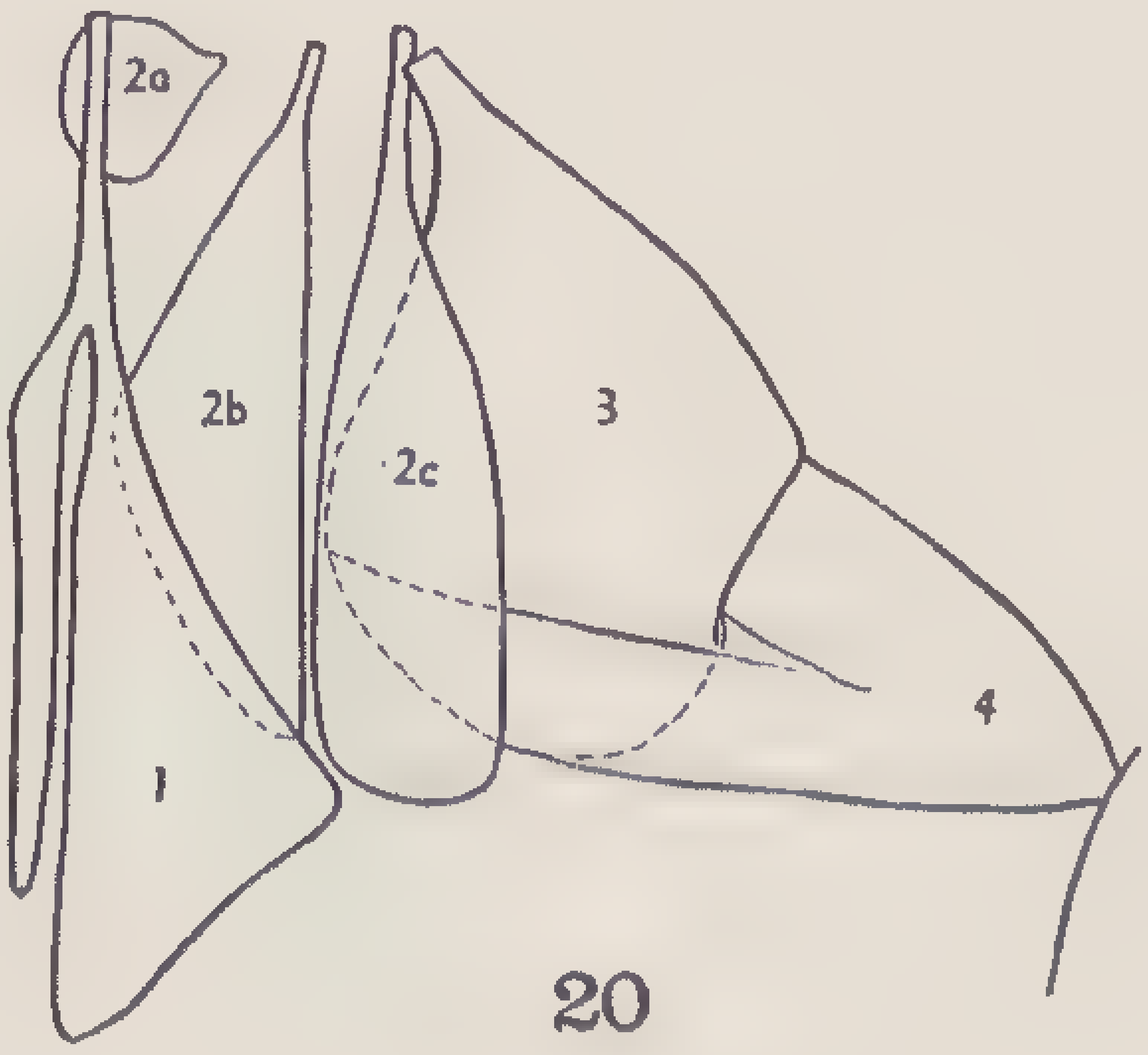


19



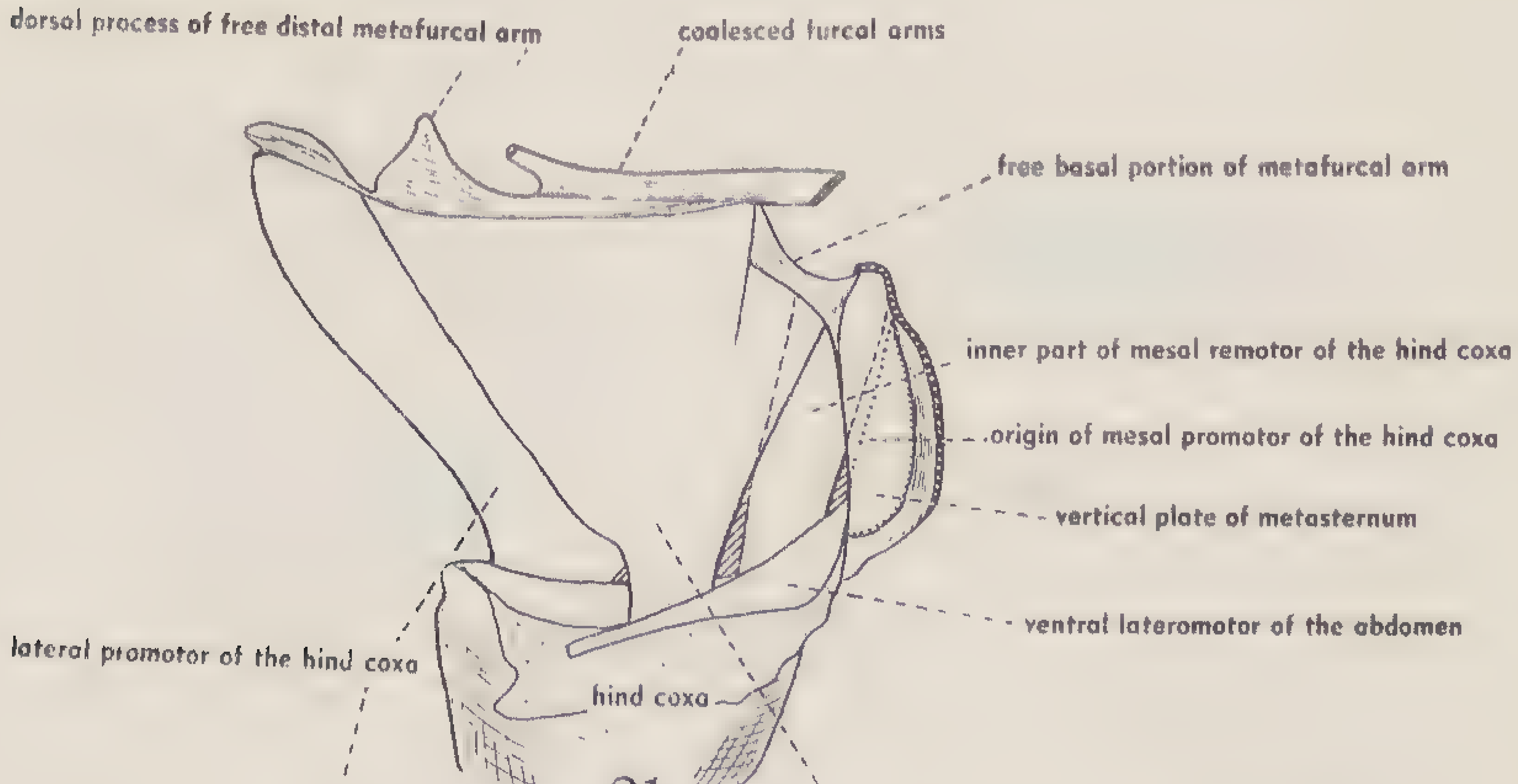
20

METATHORACIC MUSCULATURE (Left Side)

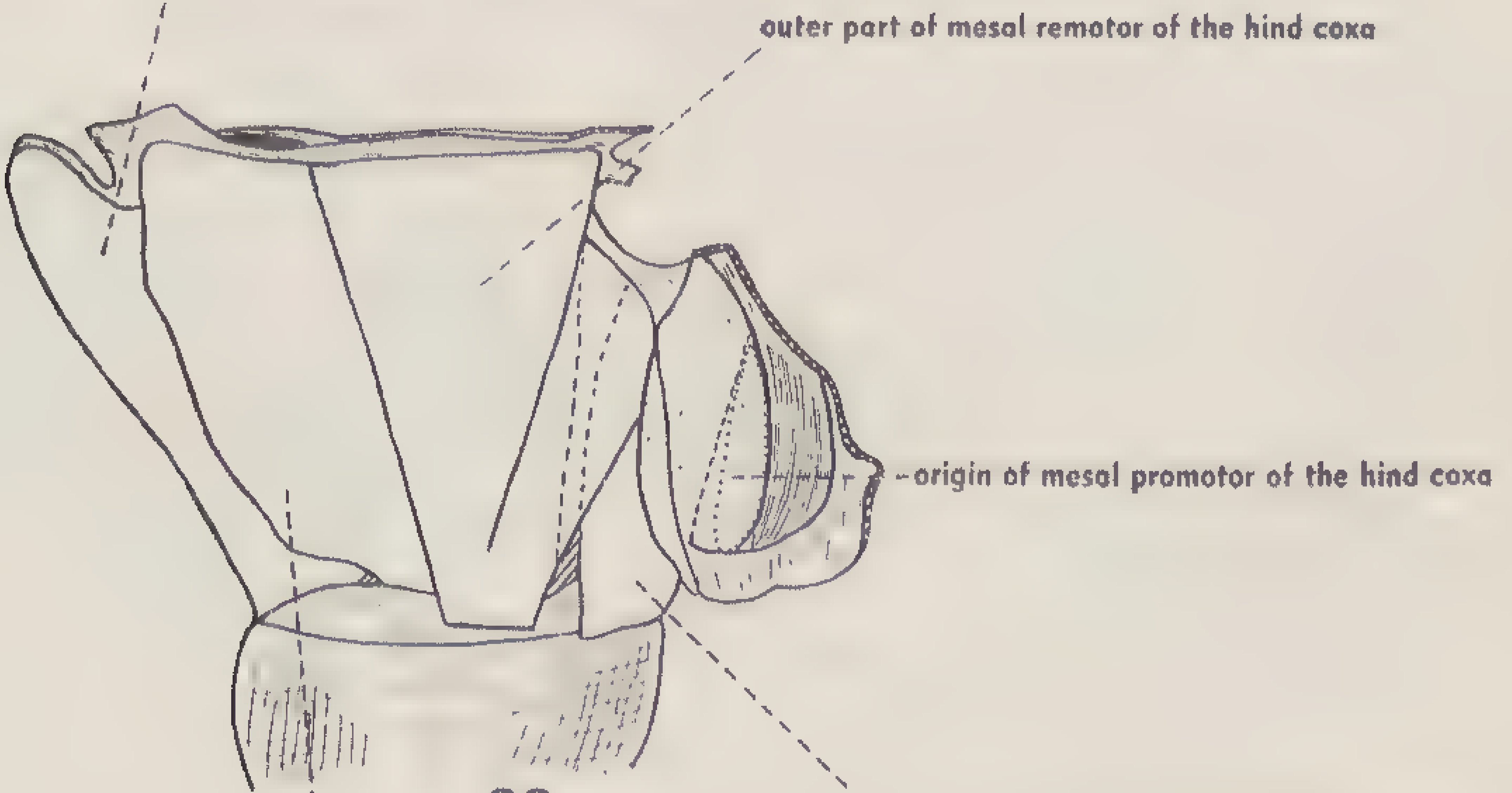
FIG. 21. *Ptiloglossa mexicana* (female). Median depressor of the abdomen and lateral remotor of the hind coxa omitted.

FIG. 22. *Nomia nortoni* (male). Median depressor of the abdomen, ventral lateromotor of the abdomen, and lateral remotor of the hind coxa omitted.

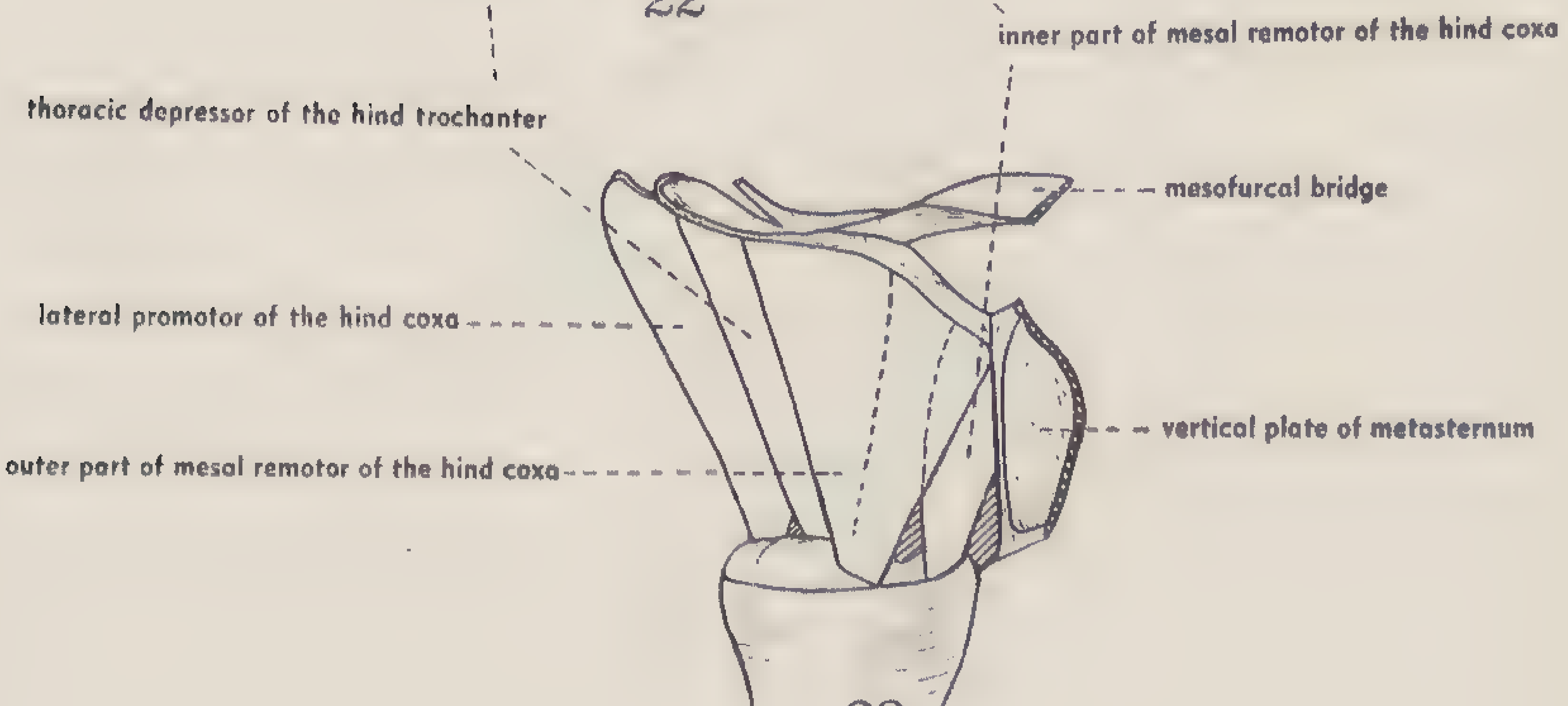
FIG. 23. *Andrena argemonis* (male). Median depressor of the abdomen, ventral lateromotor of the abdomen, and lateral remotor of the hind coxa omitted.


dorsal process of free distal metafurcal arm
coalesced furcal arms
free basal portion of metafurcal arm
inner part of mesal remotor of the hind coxa
origin of mesal promotor of the hind coxa
vertical plate of metasternum
ventral lateromotor of the abdomen
lateral promotor of the hind coxa
hind coxa

21


outer part of mesal remotor of the hind coxa
origin of mesal promotor of the hind coxa

22


inner part of mesal remotor of the hind coxa
thoracic depressor of the hind trochanter
mesofurcal bridge
lateral promotor of the hind coxa
vertical plate of metasternum
outer part of mesal remotor of the hind coxa

23

METATHORACIC MUSCULATURE (Left Side)

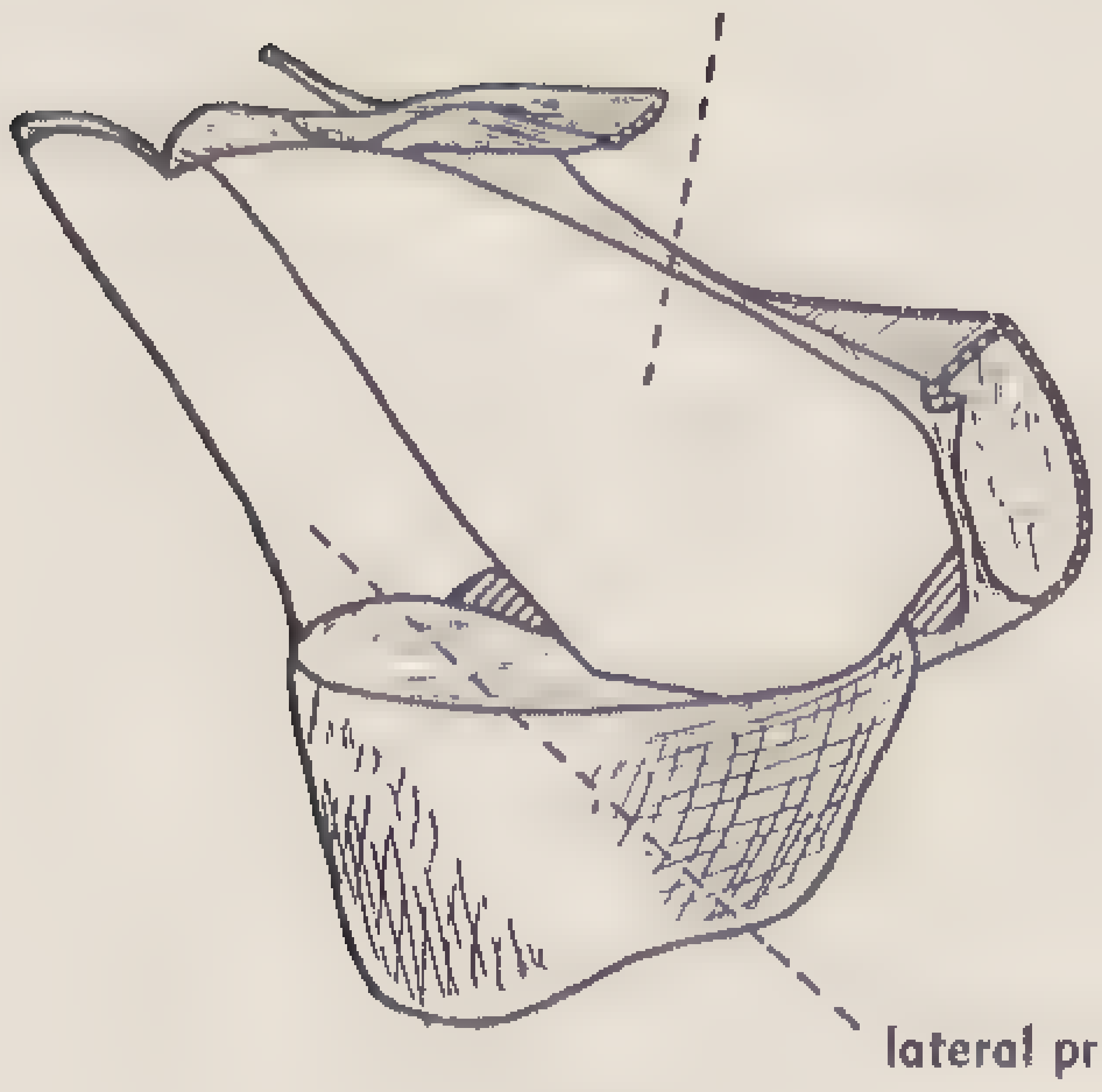
FIG. 24. *Pseudopanurgus* sp. (female). Median depressor of the abdomen, ventral lateromotor of the abdomen, and lateral remotor of the hind coxa omitted.

FIG. 25. *Protoxaea nigerrima* (female). Promotors of the hind coxa.

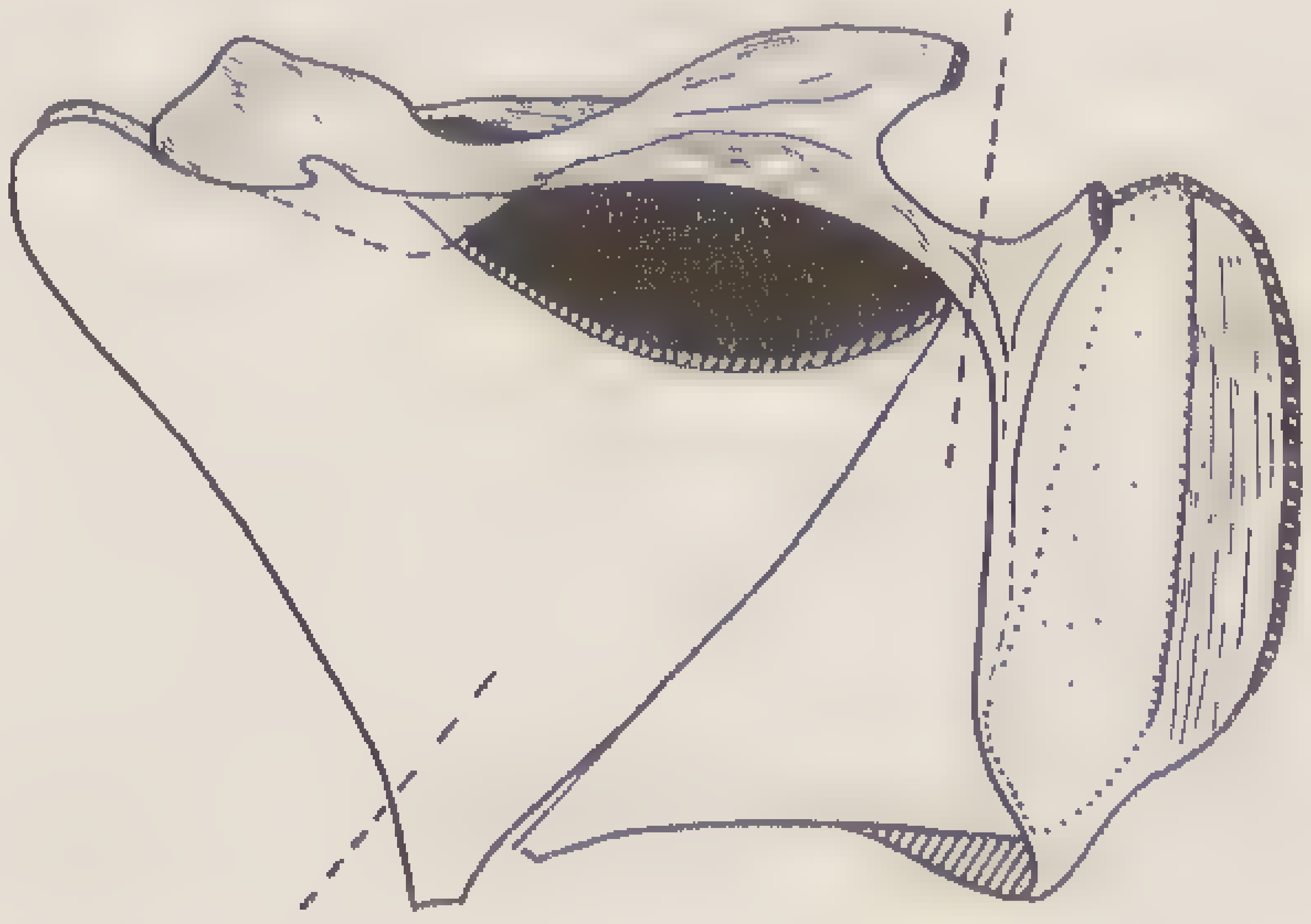
FIG. 26. *Megachile* sp. (female). Median depressor of the abdomen, ventral lateromotor of the abdomen, and lateral remotor of the hind coxa omitted.

FIG. 27. *Anthidium maculosum* (female). Median depressor of the abdomen, ventral lateromotor of the abdomen, and lateral remotor of the hind coxa omitted.

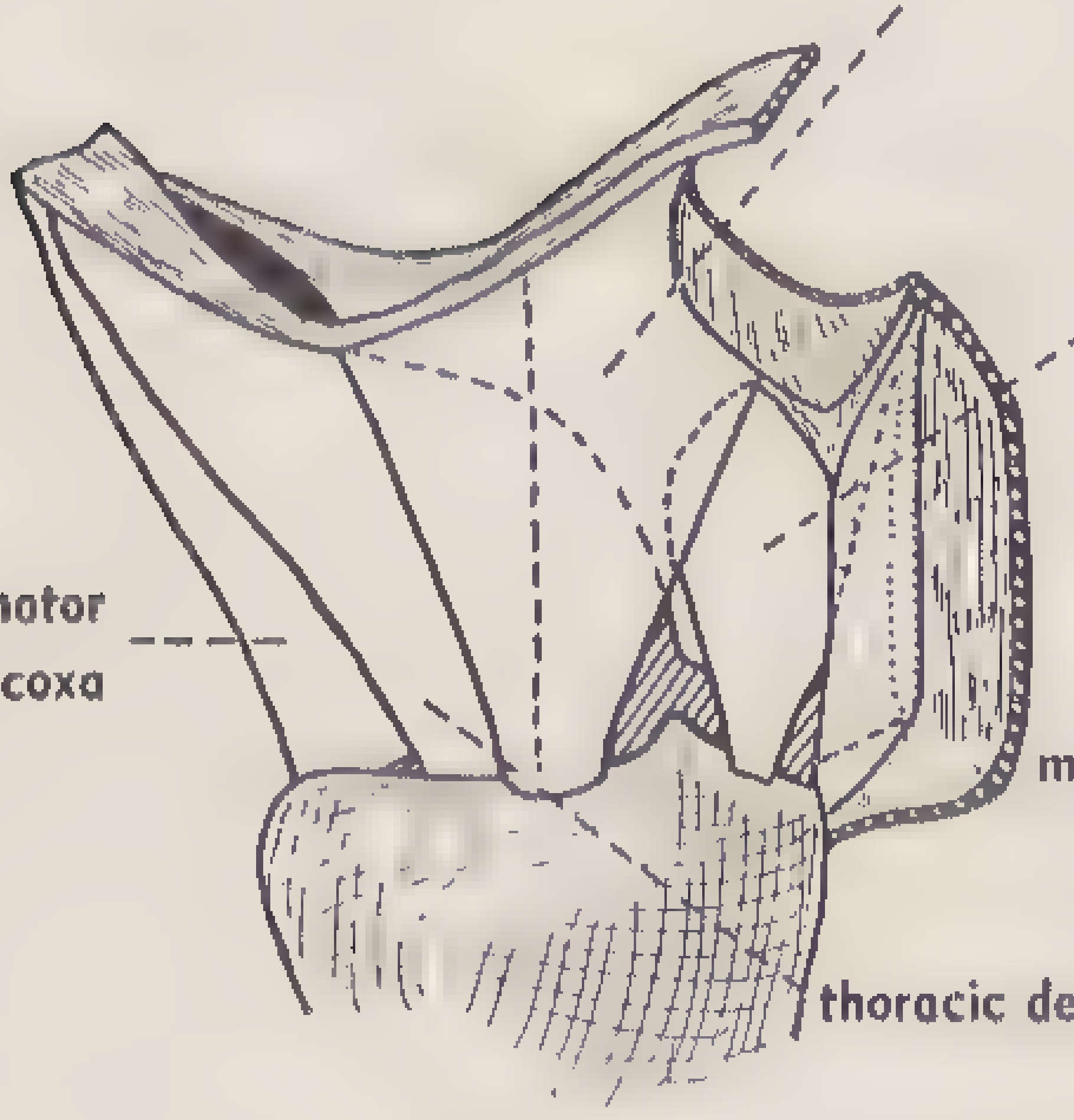
FIG. 28. *Megachile* sp. (female). Promotors of the hind coxa.


mesal remotor of the hind coxa
lateral promotor of the hind coxa

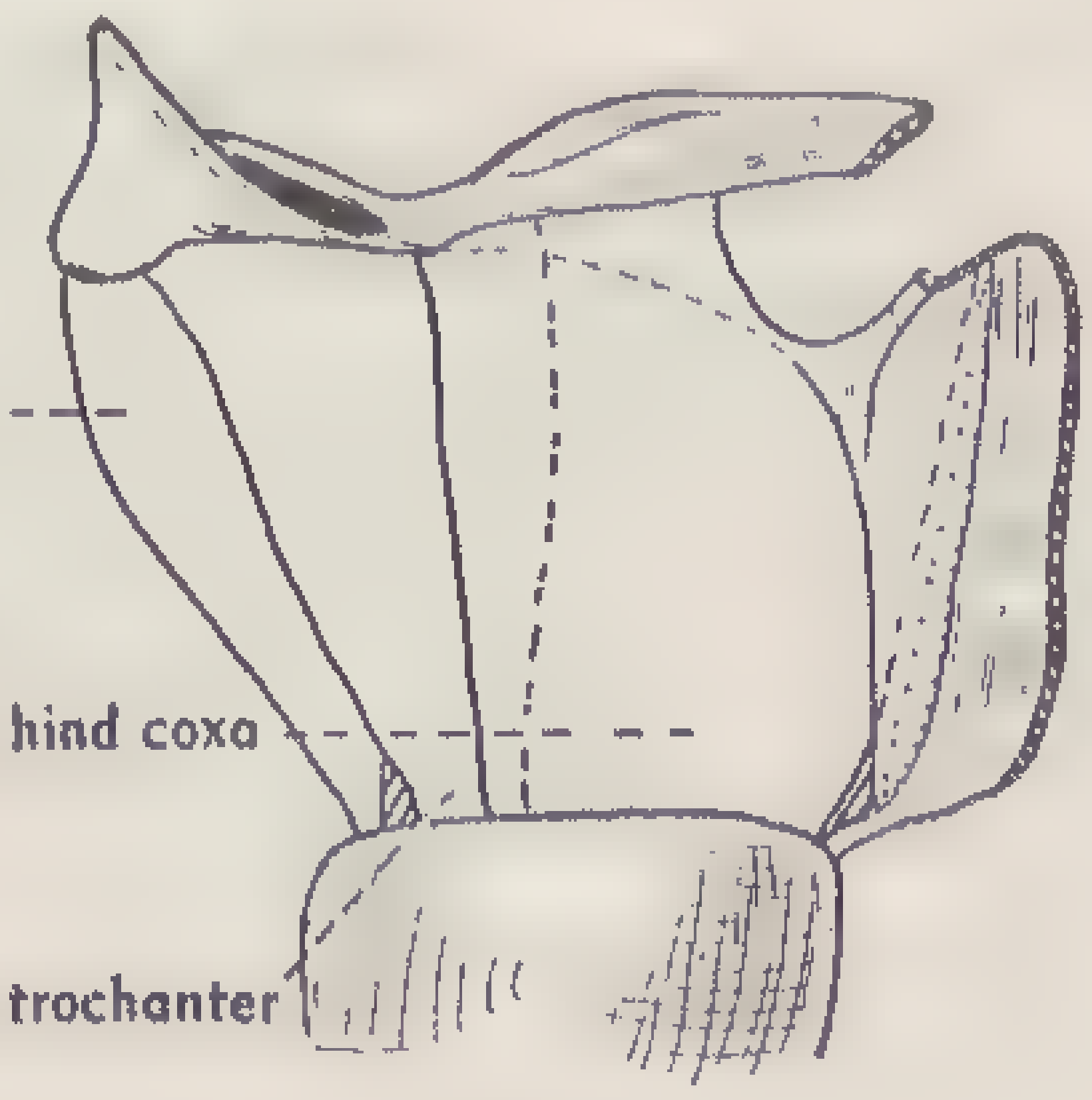
24


mesal promotor of the hind coxa

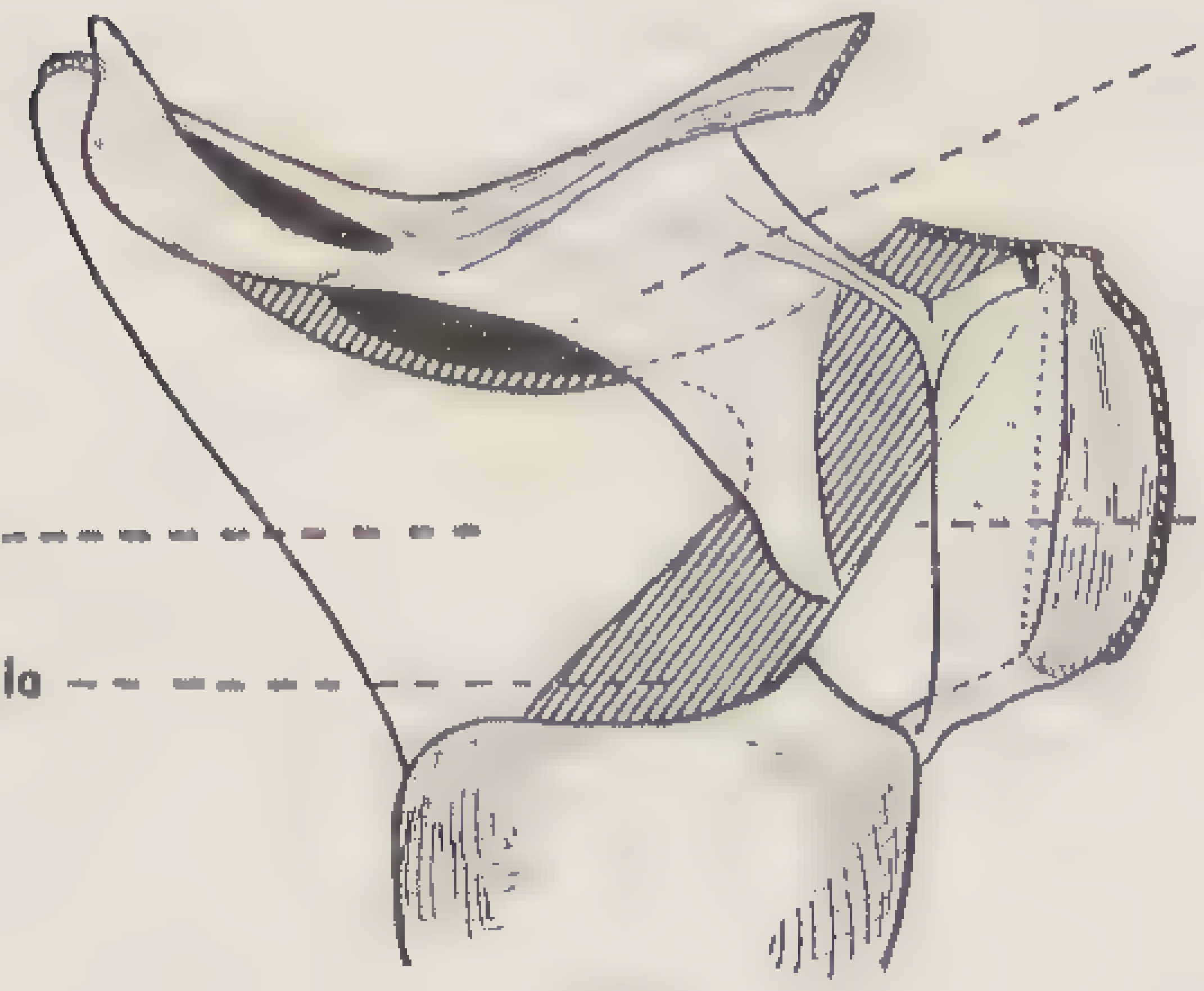
25


outer part of mesal remotor of the hind coxa
inner part of mesal remotor of the hind coxa
lateral promotor of the hind coxa
thoracic depressor of the hind trochanter

26


lateral promotor of the hind coxa
mesal remotor of the hind coxa

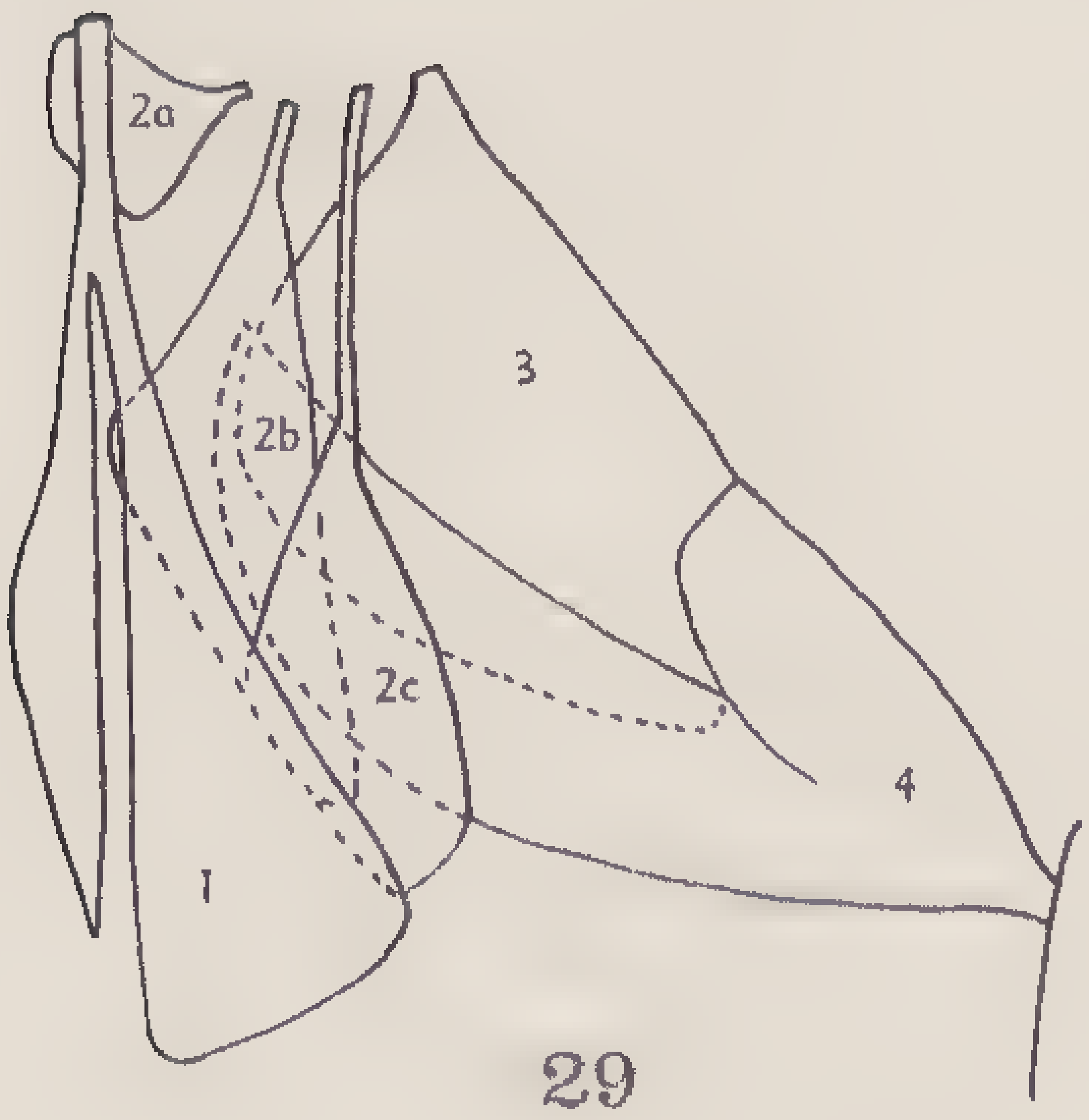
27


furcal plate
lateral promotor of the hind coxa
mesal promotor of the hind coxa
intercoxal lamella

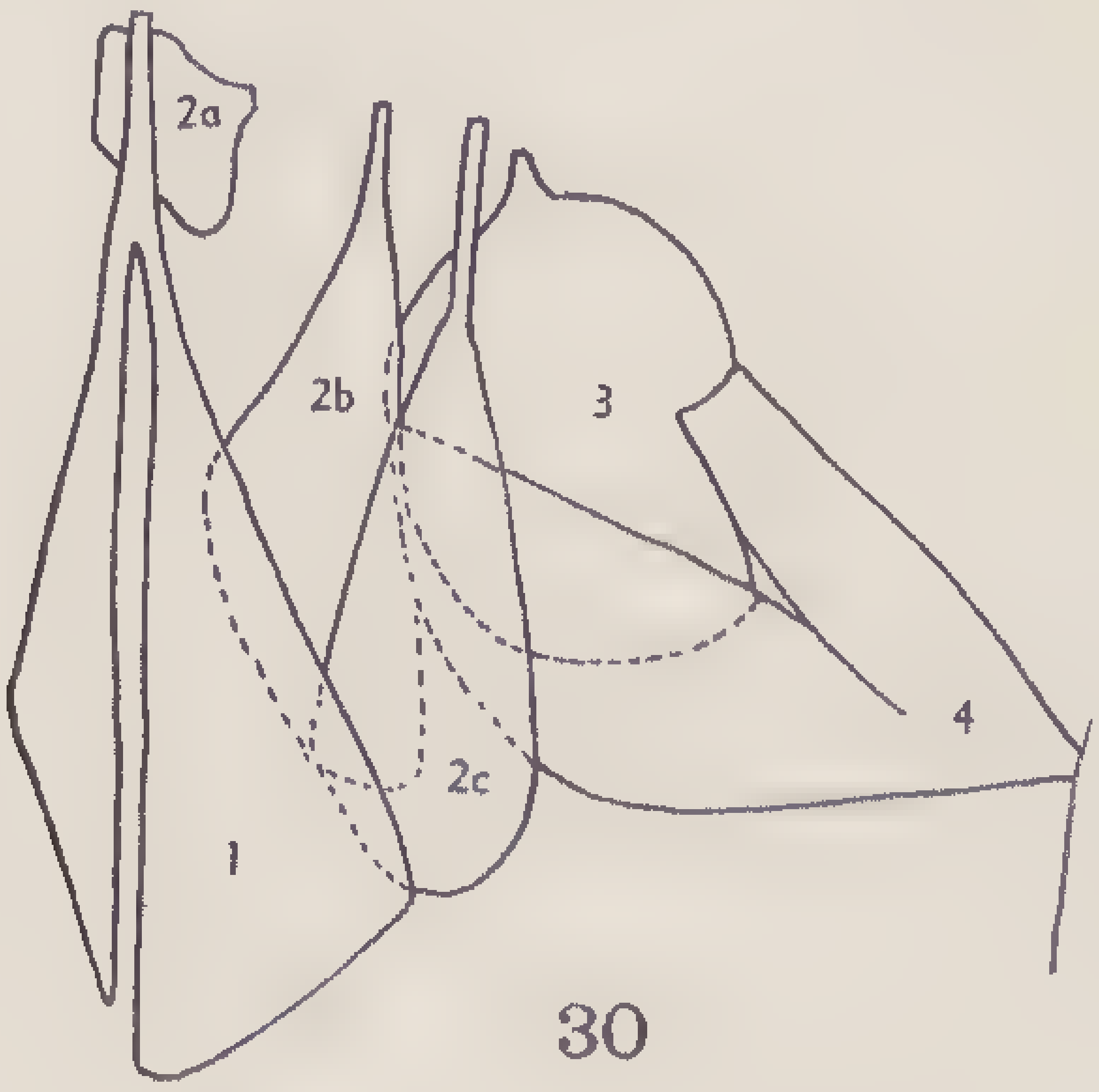
28

MESOPLEURAL MUSCULATURE (Right Side)

FIG. 29. *Exomalopsis* sp. (female).
FIG. 30. *Exomalopsis* sp. (female).
FIG. 31. *Ancyloscelis armatus* (female).
FIG. 32. *Paratetrapedia* sp. (male).
FIG. 33. *Paratetrapedia* sp. (male).
FIG. 34. *Tetrapedia maura* (female).



29



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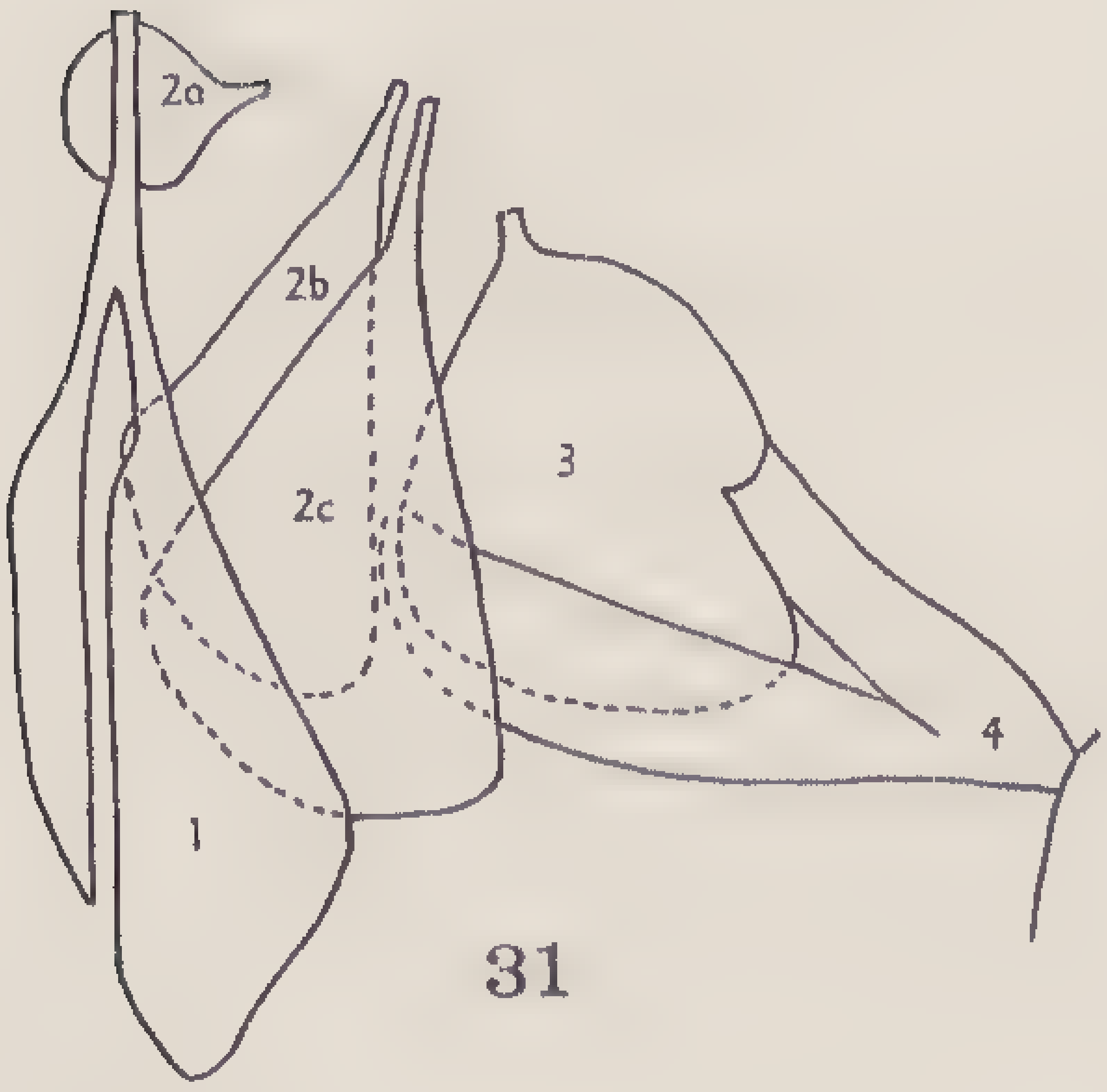
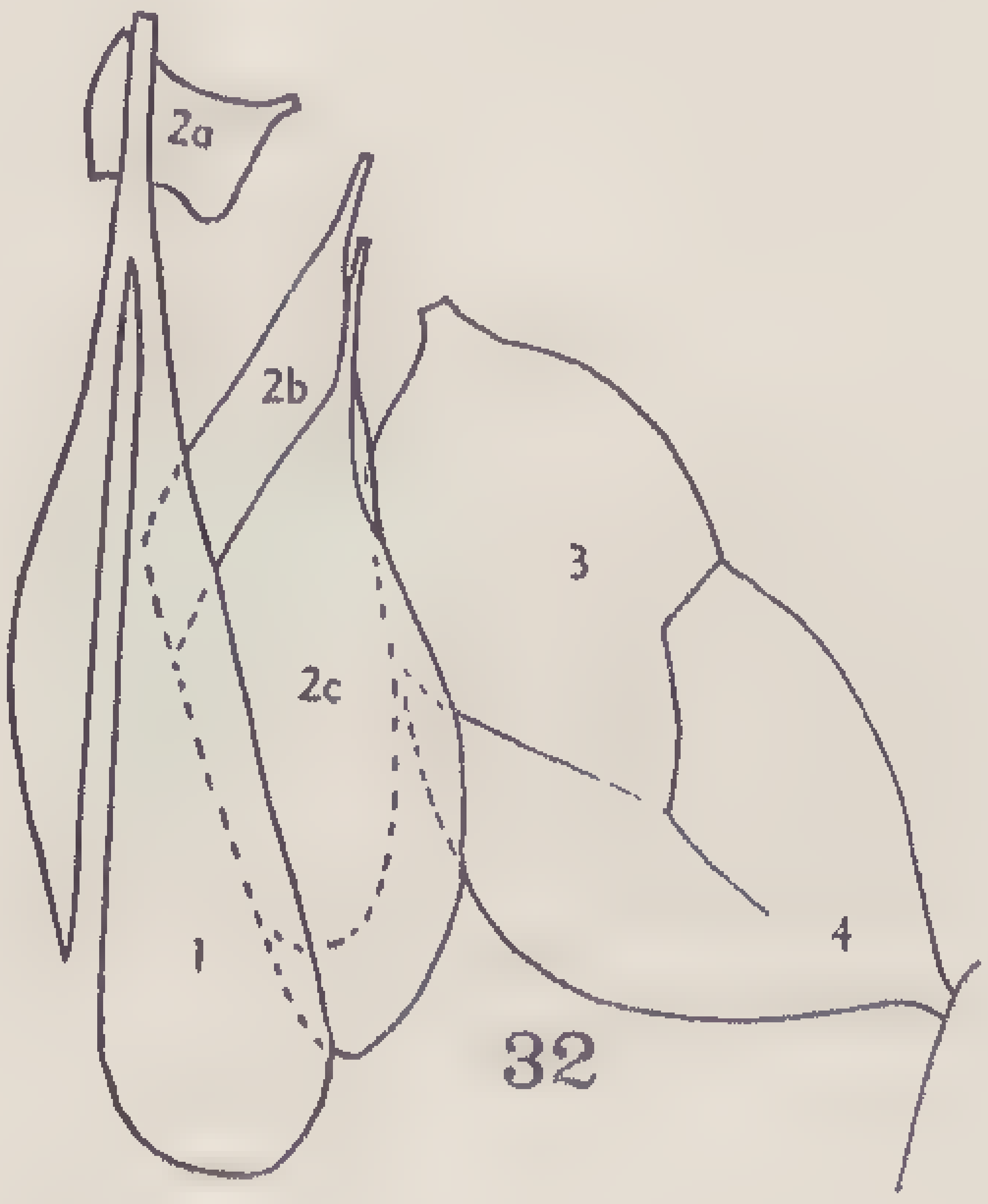
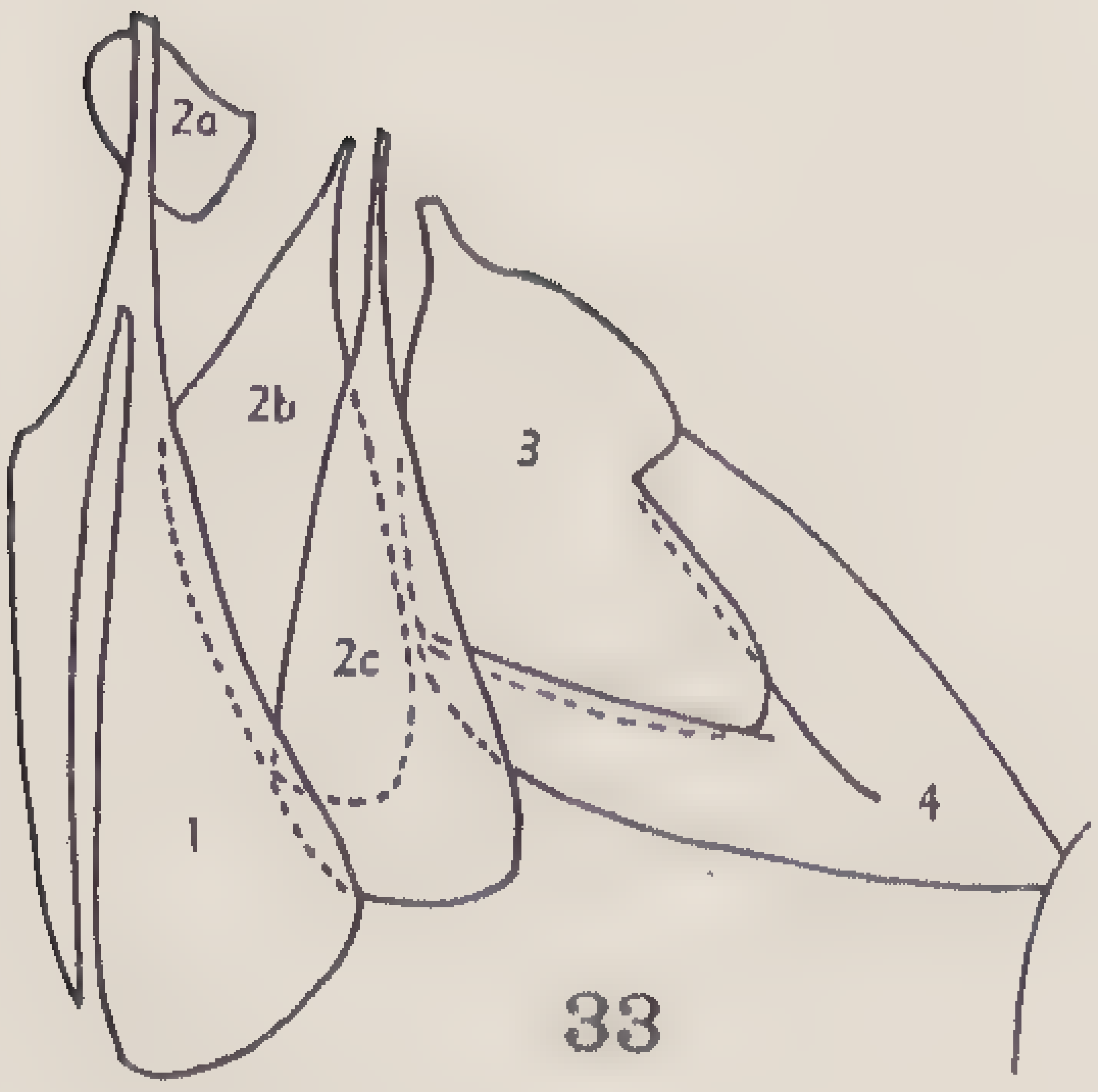


31



32



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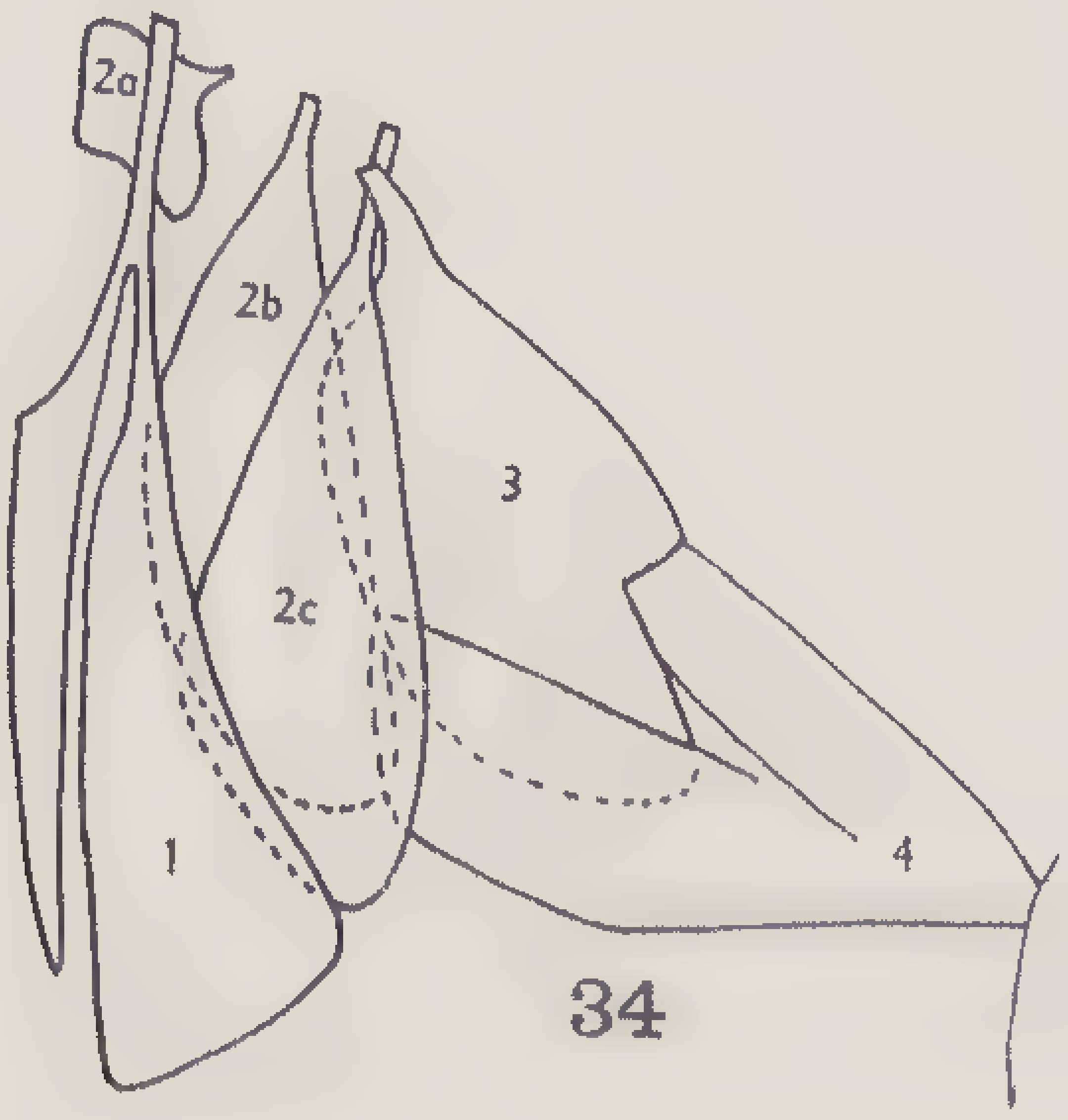
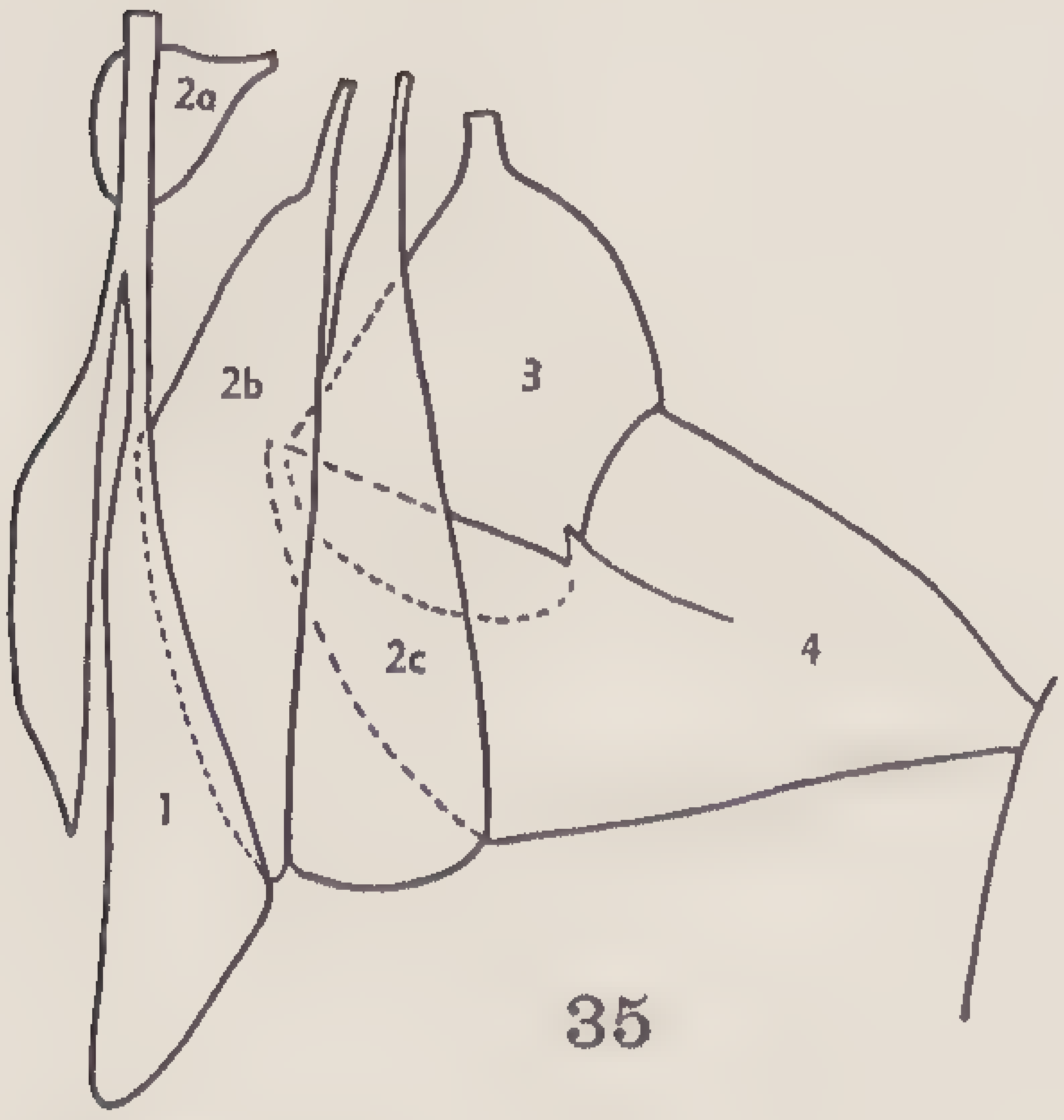


34

MESOPLEURAL MUSCULATURE (Right Side)

FIG. 35. *Nomada* (*Micronomada*) sp. (male).
FIG. 36. *Neopasites* sp. (female).
FIG. 37. *Triepeolus* sp. (female).
FIG. 38. *Melissodes obliqua* (female).
FIG. 39. *Melissodes coloradensis* (female).
FIG. 40. *Melissodes communis* (female).



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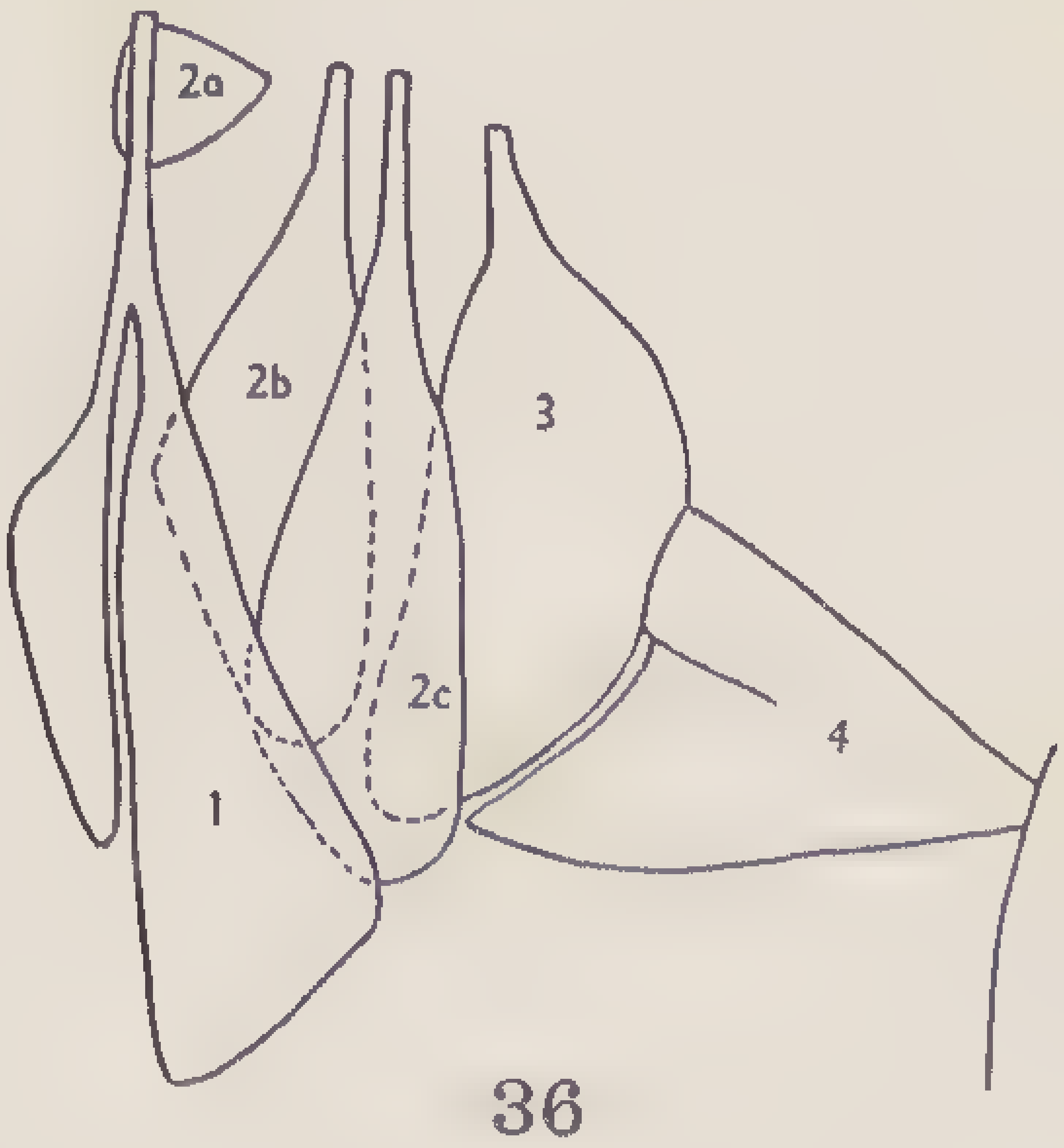

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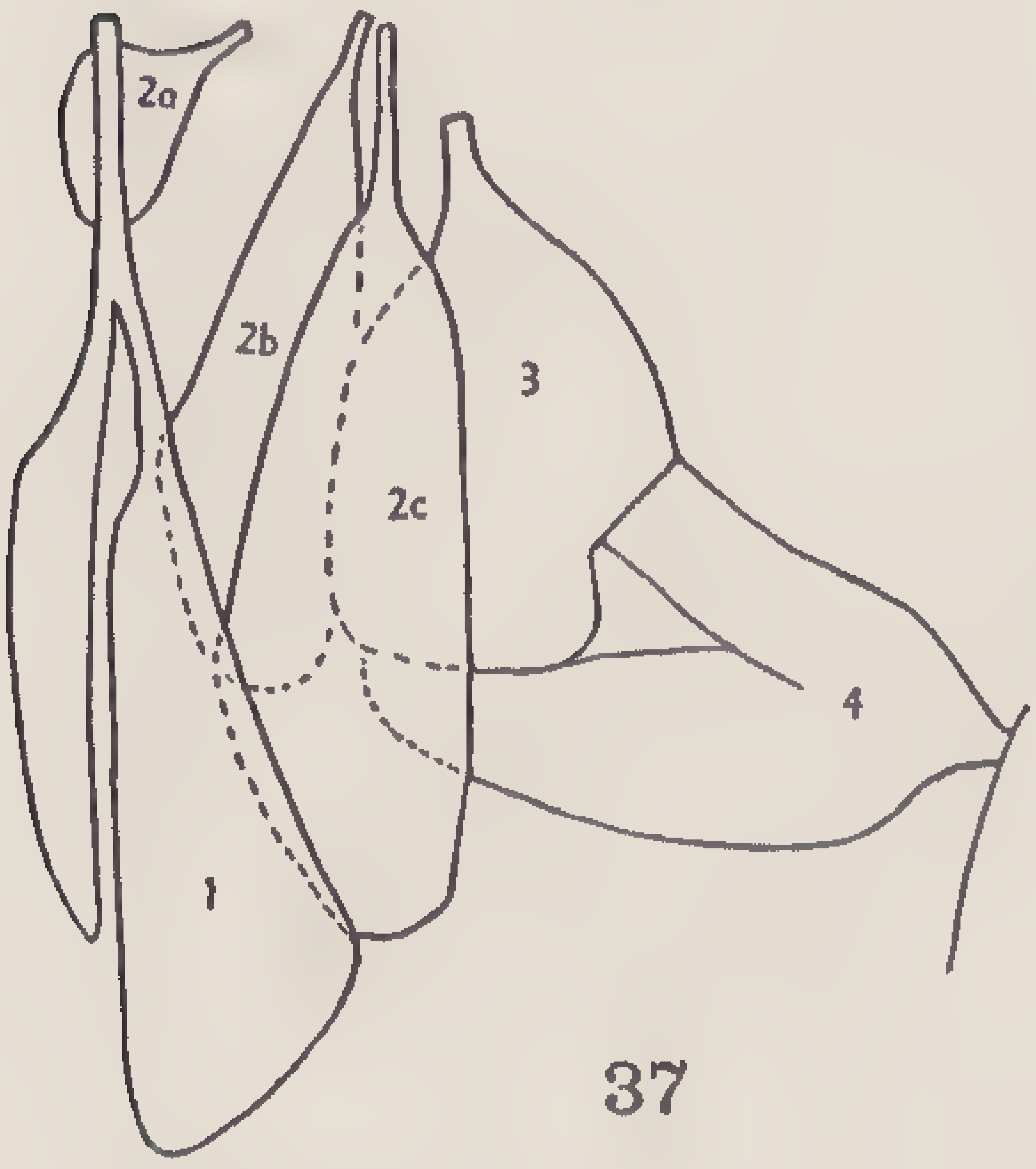

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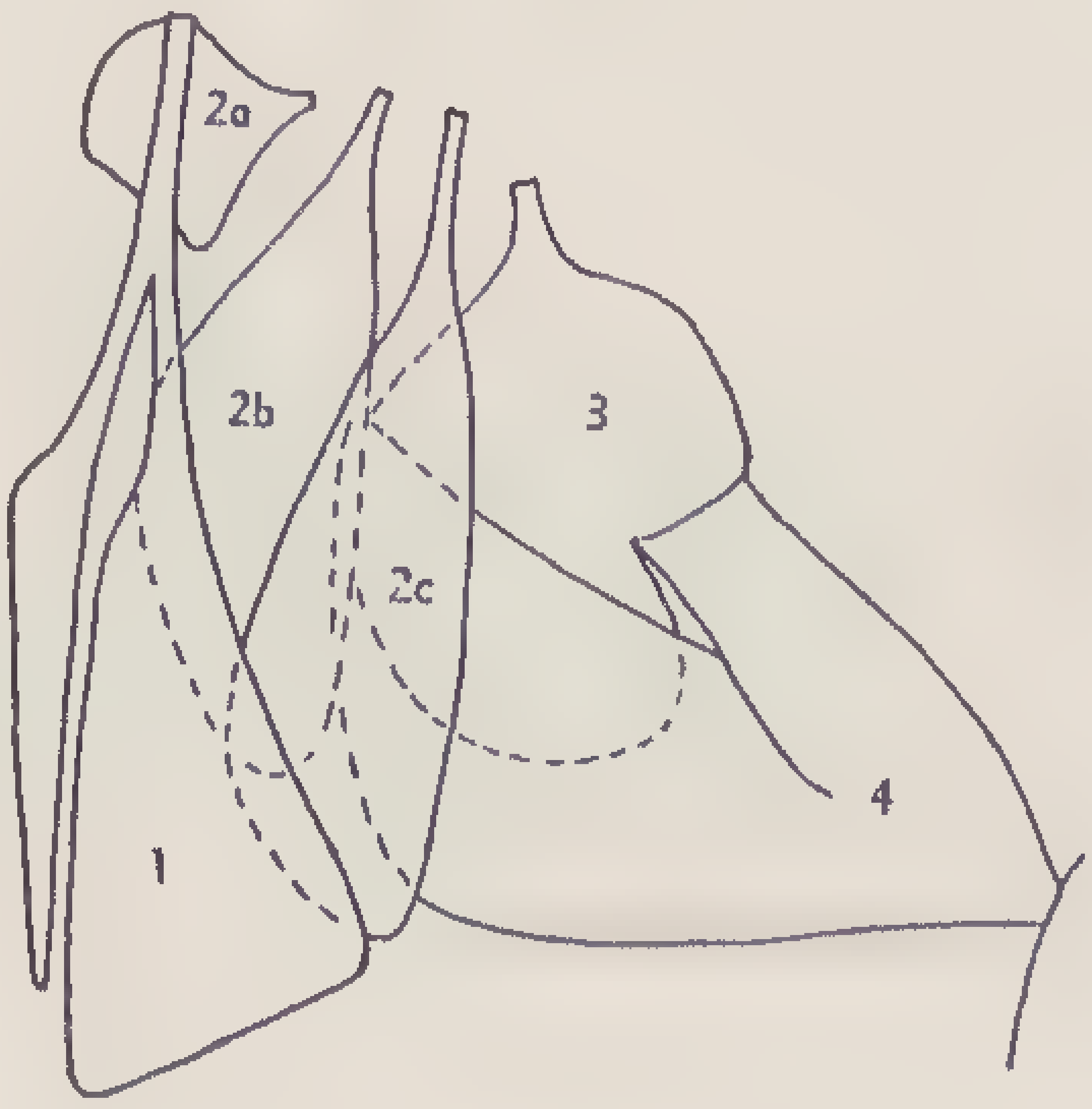
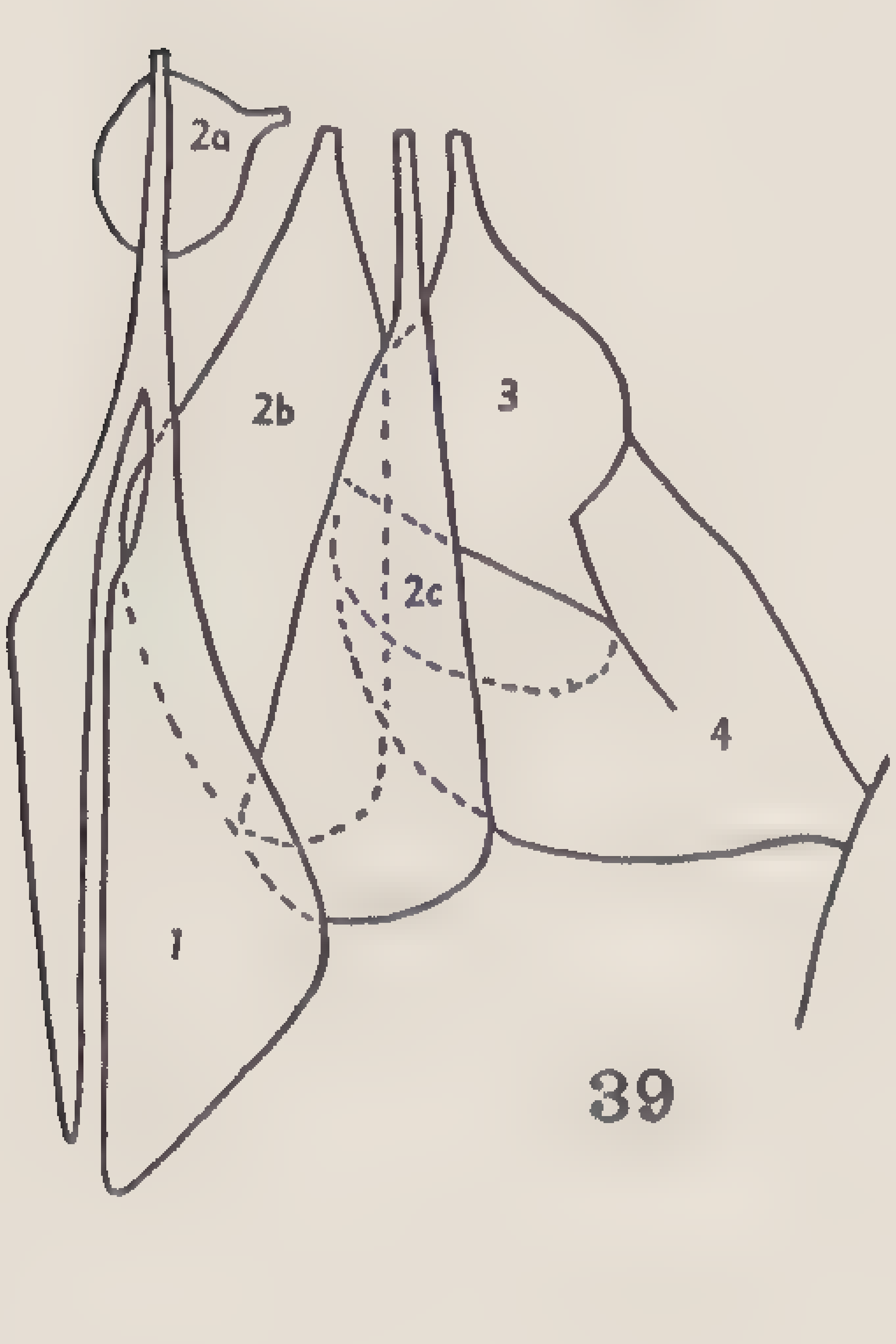


38



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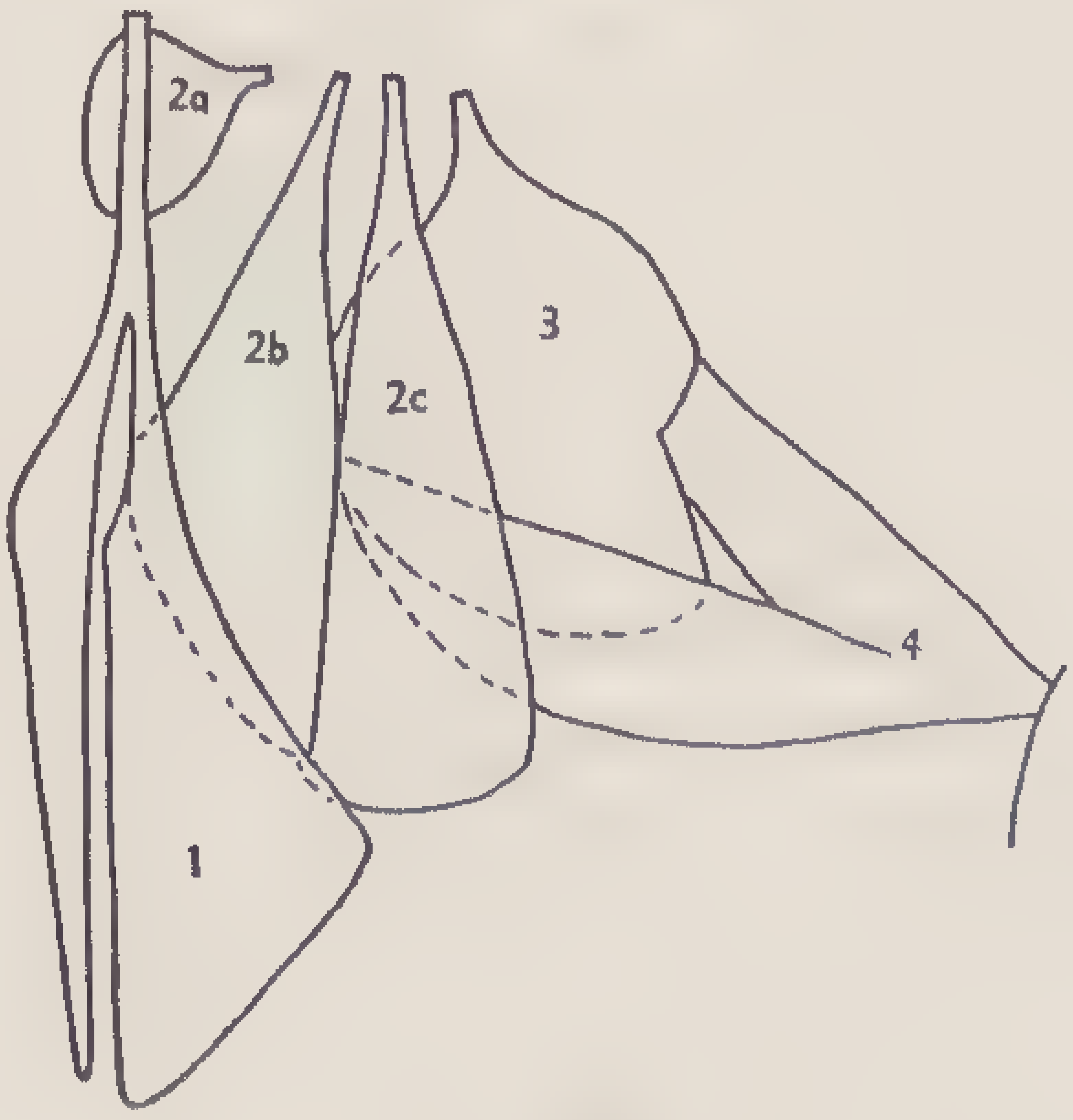
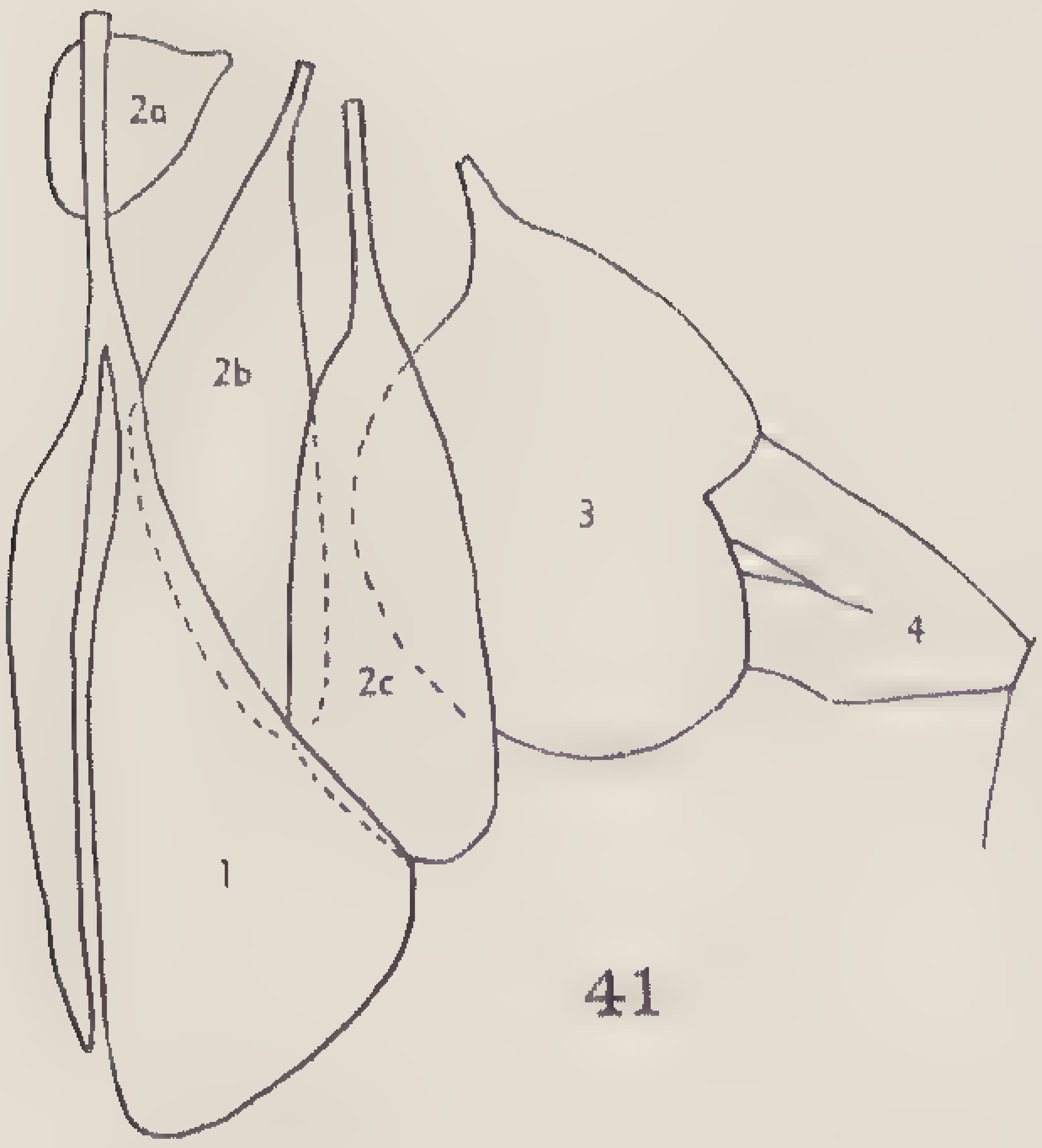


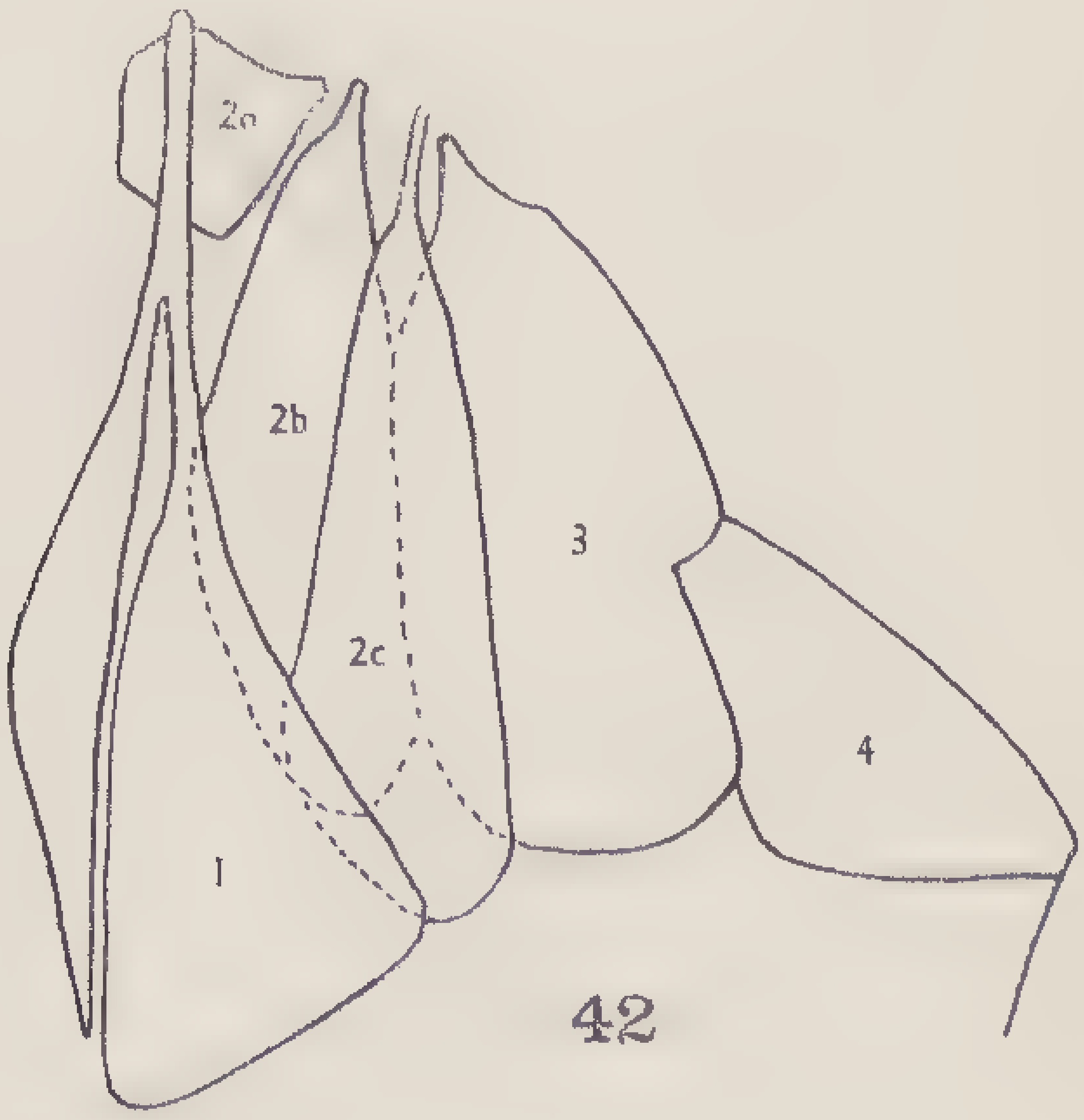
40

MESOPLEURAL MUSCULATURE (Right Side)

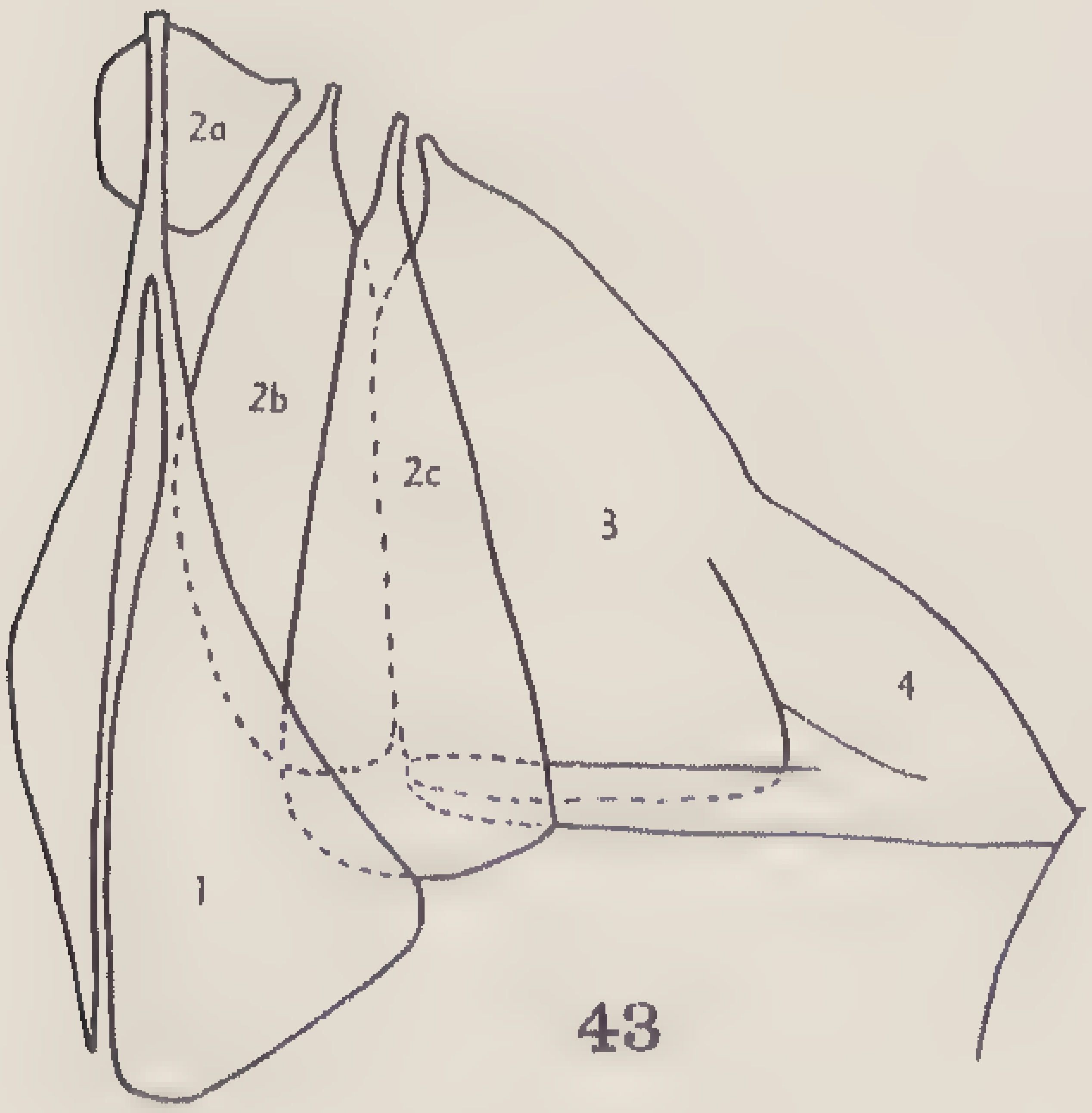
FIG. 41. *Thygater* near *analis* (female).
FIG. 42. *Peponapis* sp. (female).
FIG. 43. *Xenoglossa* near *fulva* (female).
FIG. 44. *Ptilothrix sumichrastii* (female).
FIG. 45. *Diadasia* near *diminuta* (female).
FIG. 46. *Diadasia enevata* (female).



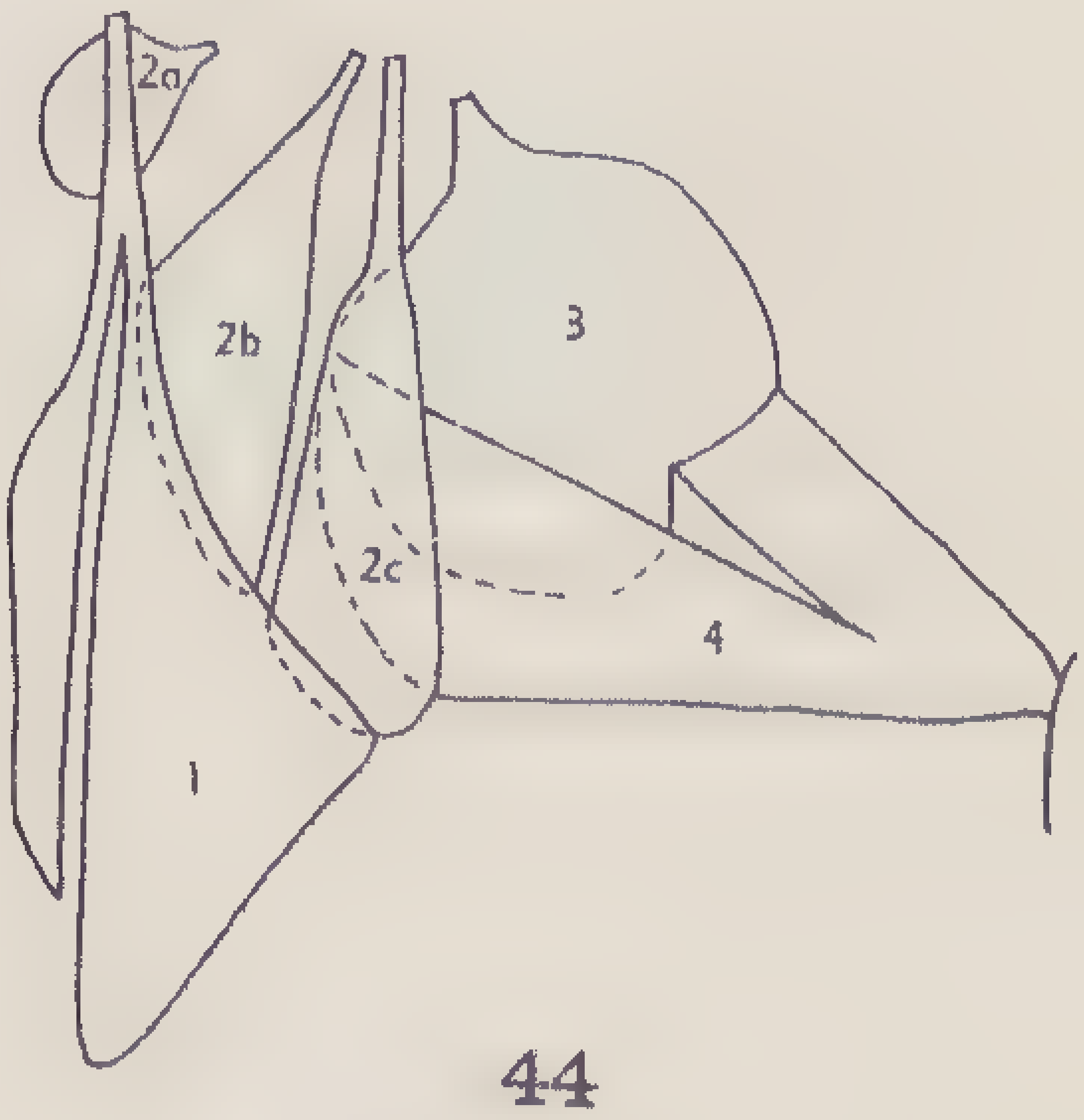
41



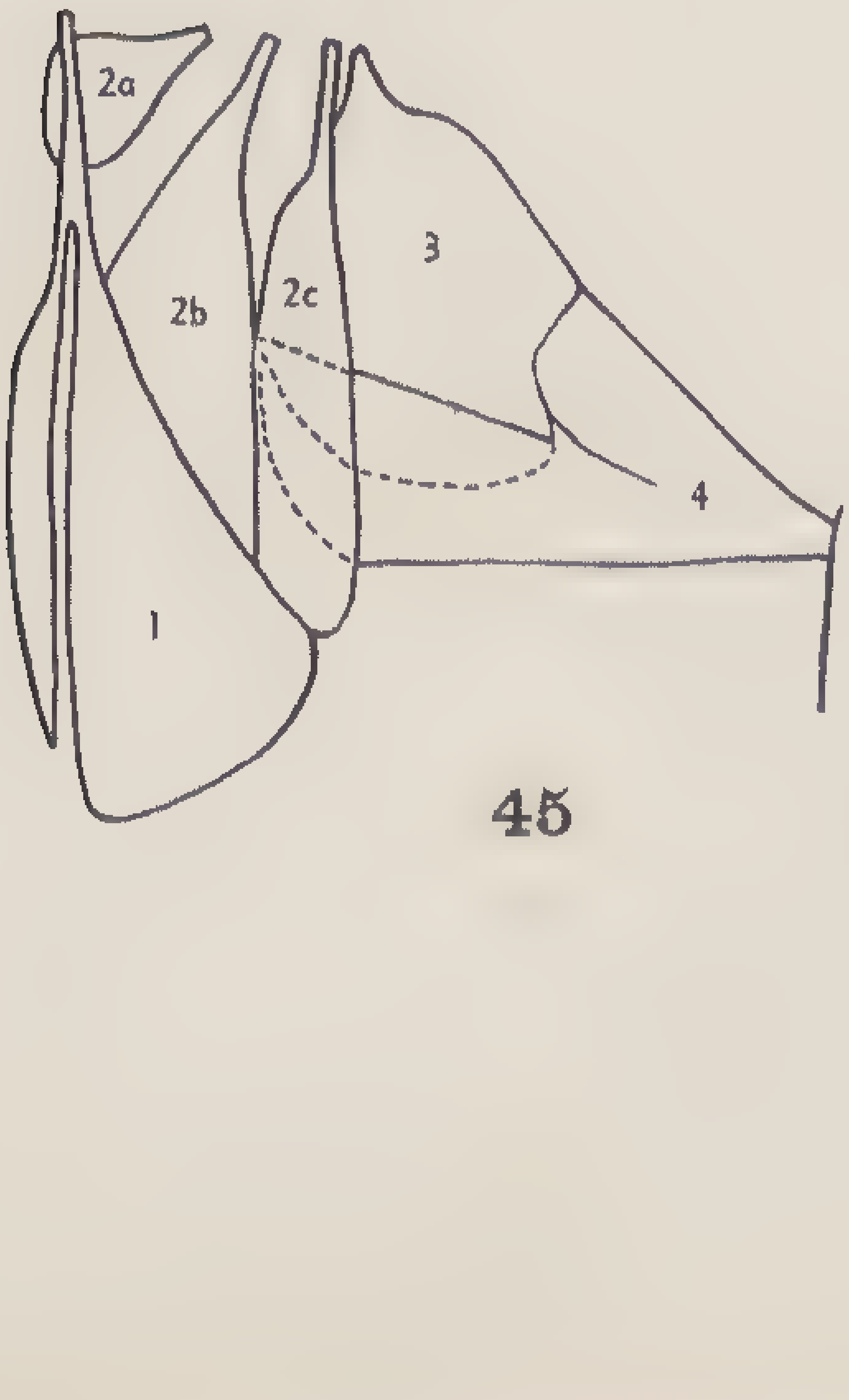
42



43



44



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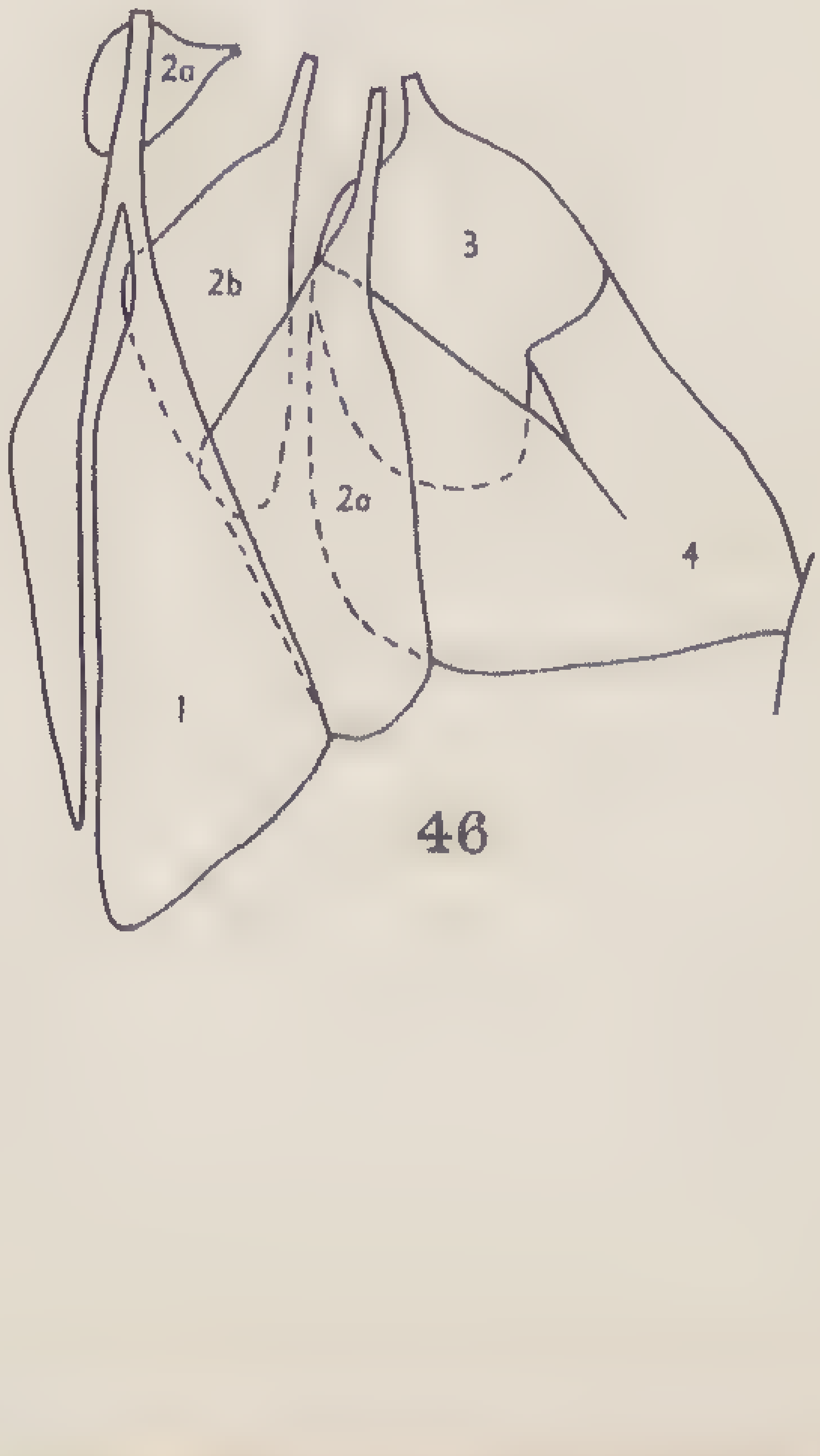

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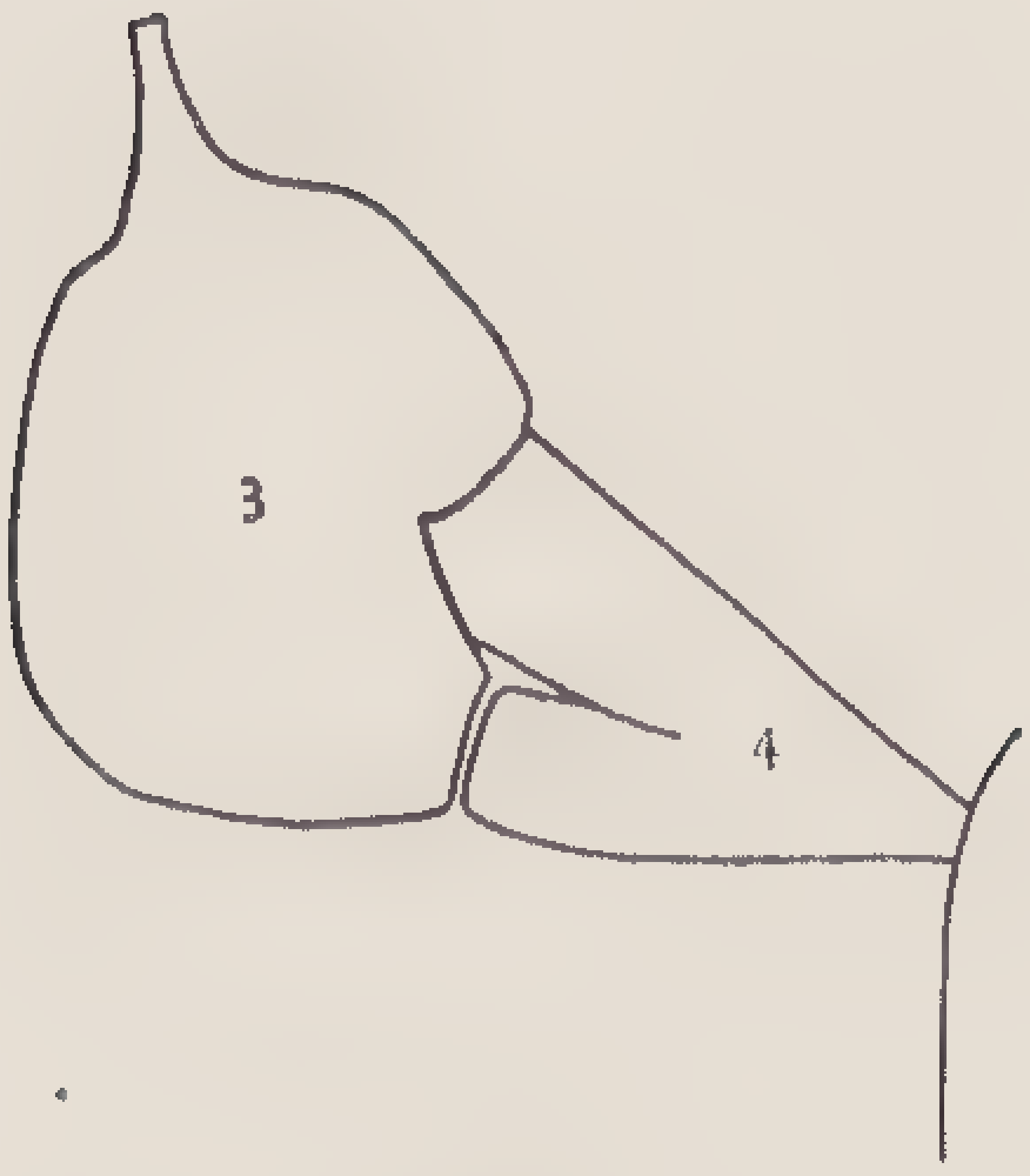
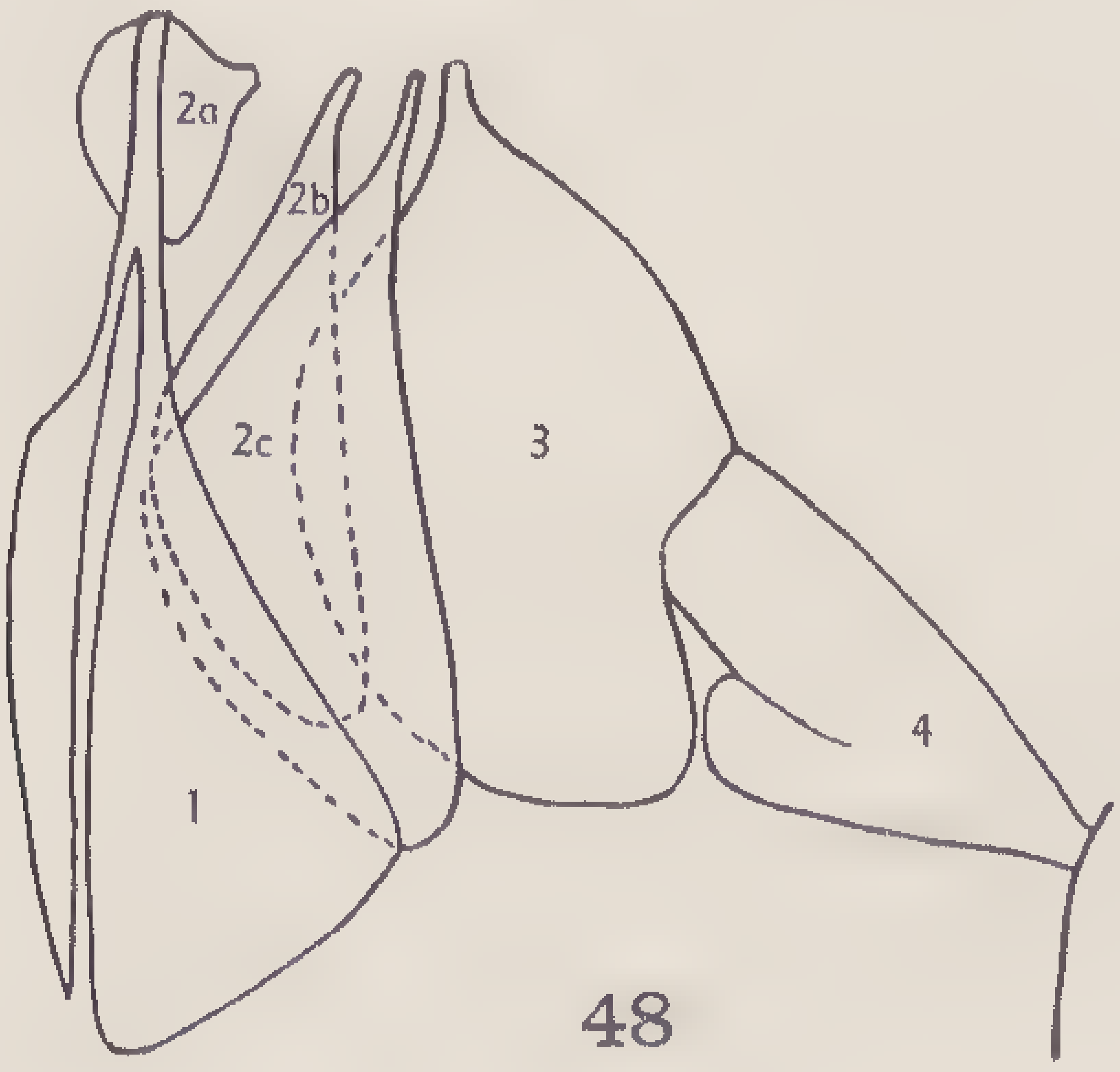
MESOPLEURAL MUSCULATURE (Right Side)

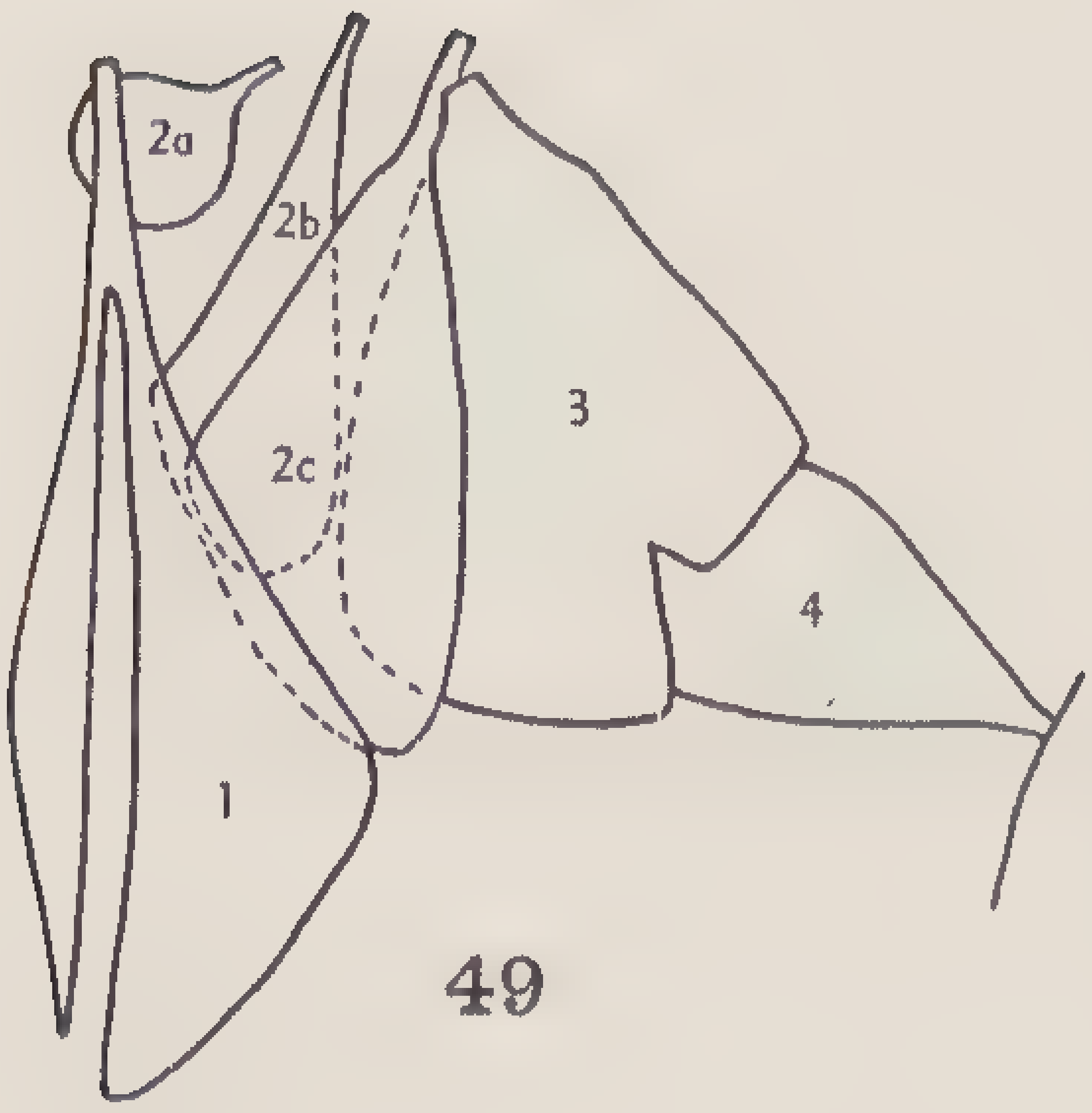
FIG. 47. *Melitoma euglossoides* (female) 1, 2a, 2b and 2c muscles omitted.
FIG. 48. *Anthophora californica Texana* (female).
FIG. 49. *Centris* near *agilis* (female).
FIG. 50. *Epicharis* sp. (female).
FIG. 51. *Xylocopa Fimbriata* (female).
FIG. 52. *Ceratina ignara* (female).



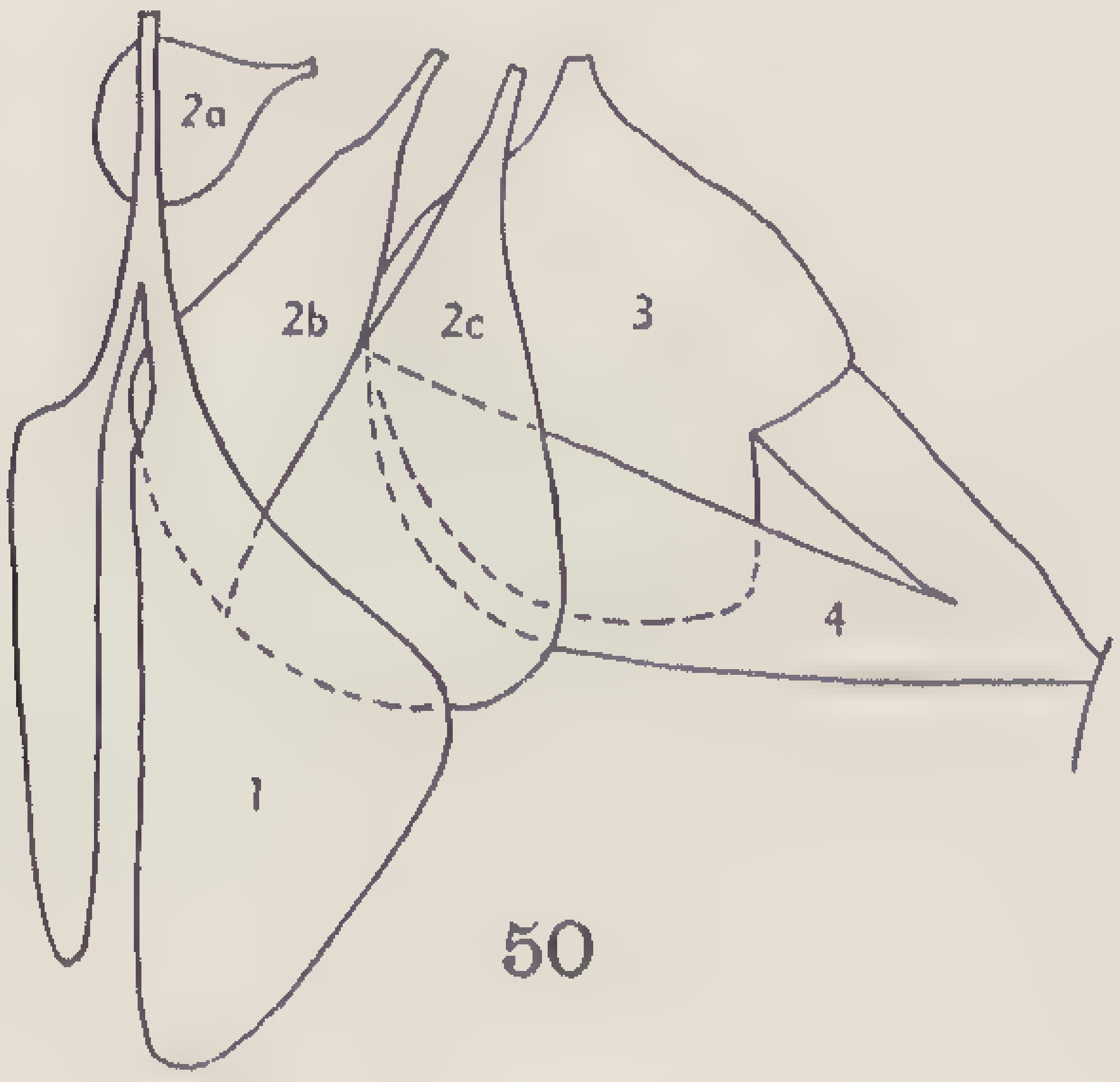
47



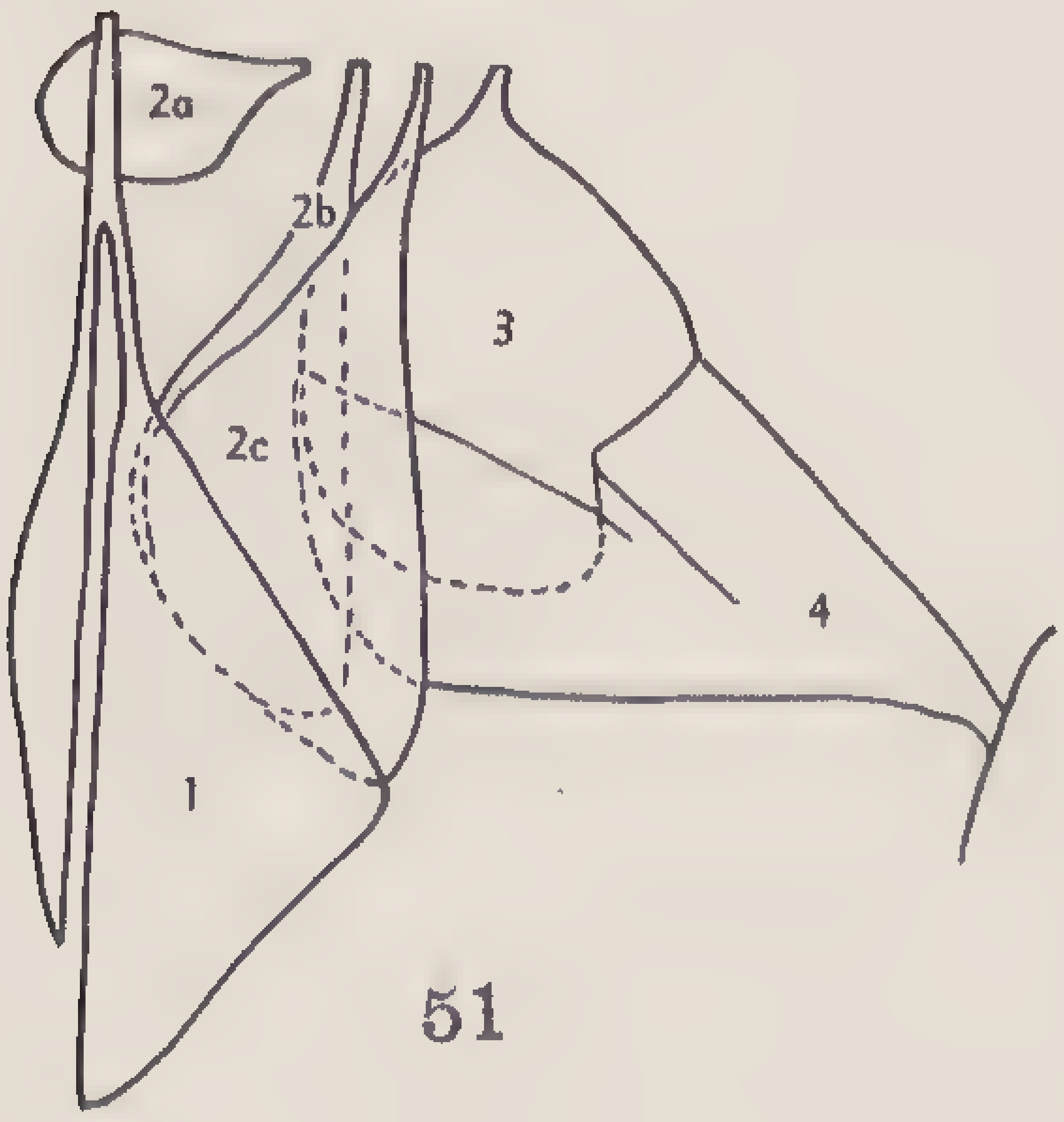
48



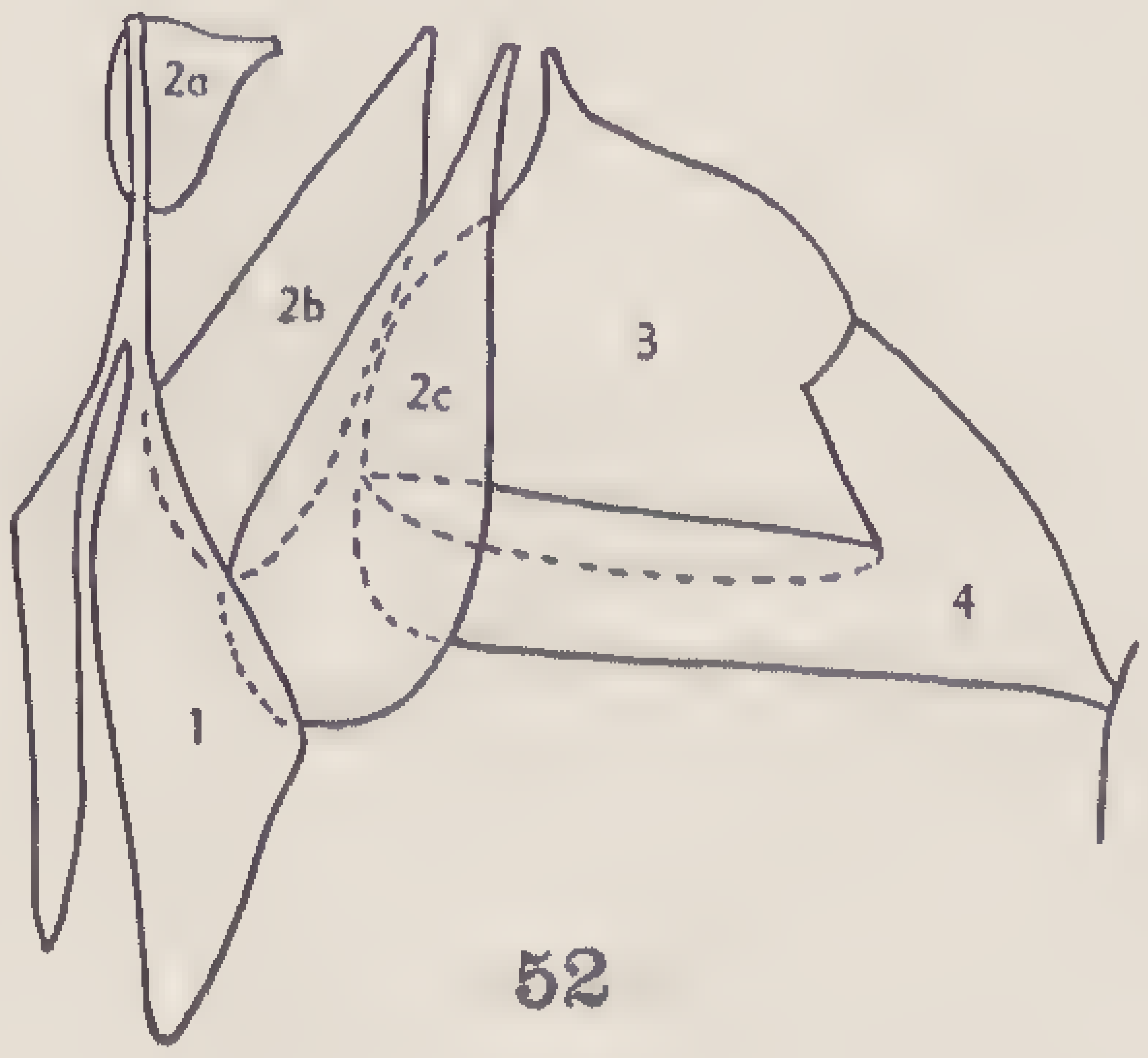
49



50



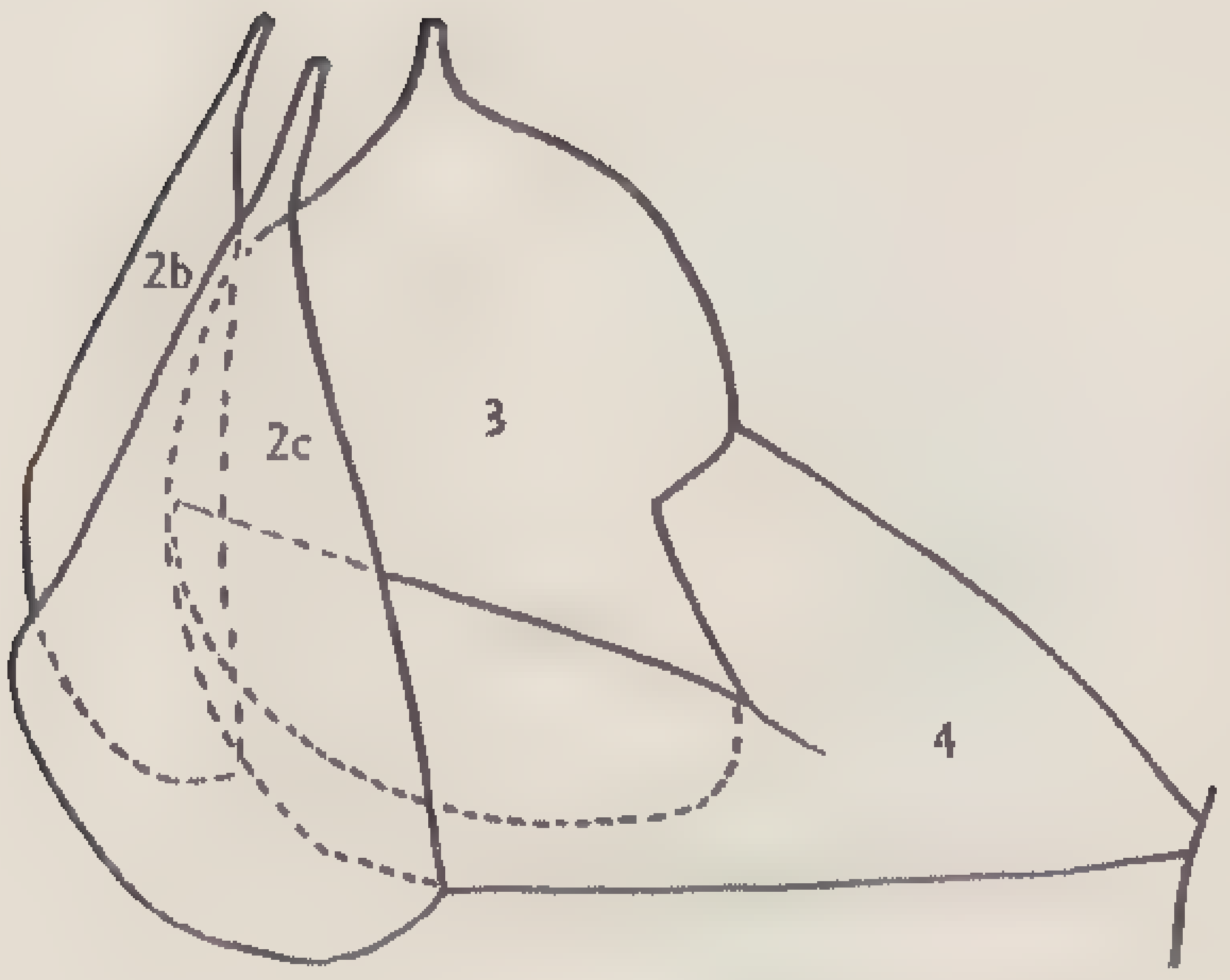
51



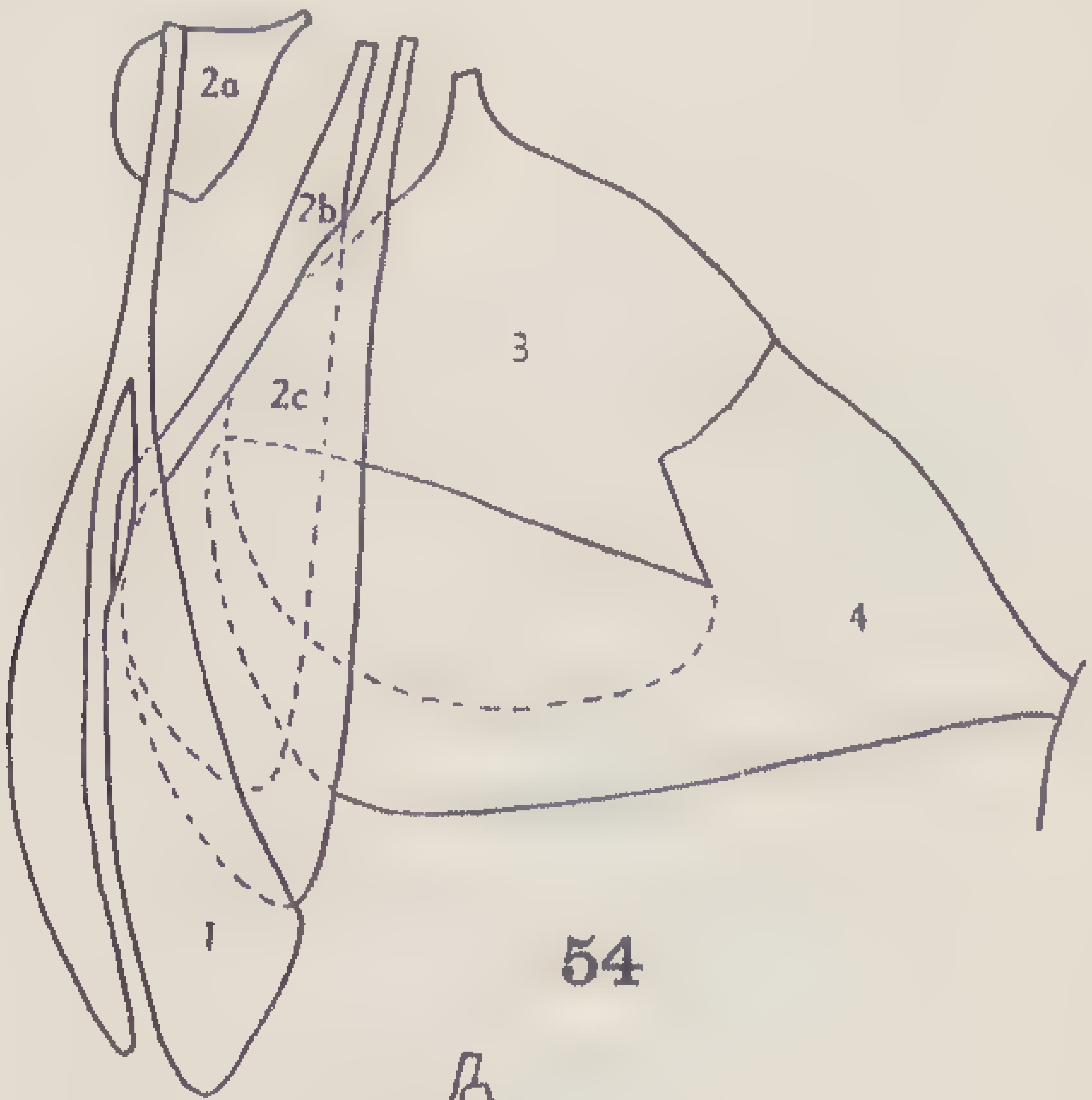
52

MESOPLEURAL MUSCULATURE (Right Side)

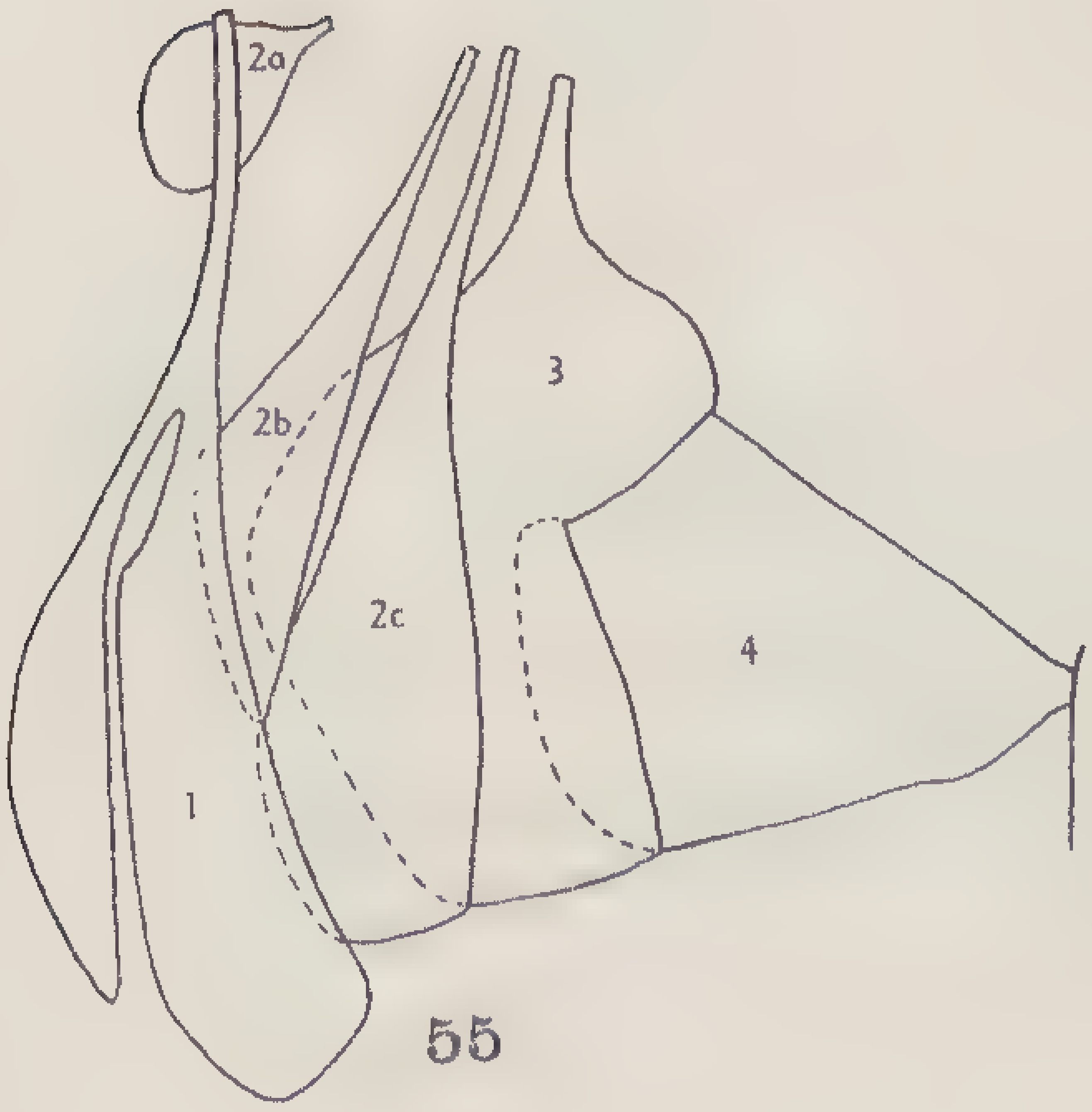
FIG. 53. *Euglossa (Euglossa)* sp. (female). 1 muscle omitted.
FIG. 54. *Bombus medius* (female).
FIG. 55. *Melipona beechei* (female).
FIG. 56. *Apis mellifica* (male). 2a muscle omitted.
FIG. 57. *Apis mellifica* (male, see page 469). 2a muscle omitted.
FIG. 58. *Apis mellifica* (worker). 2a muscle omitted.



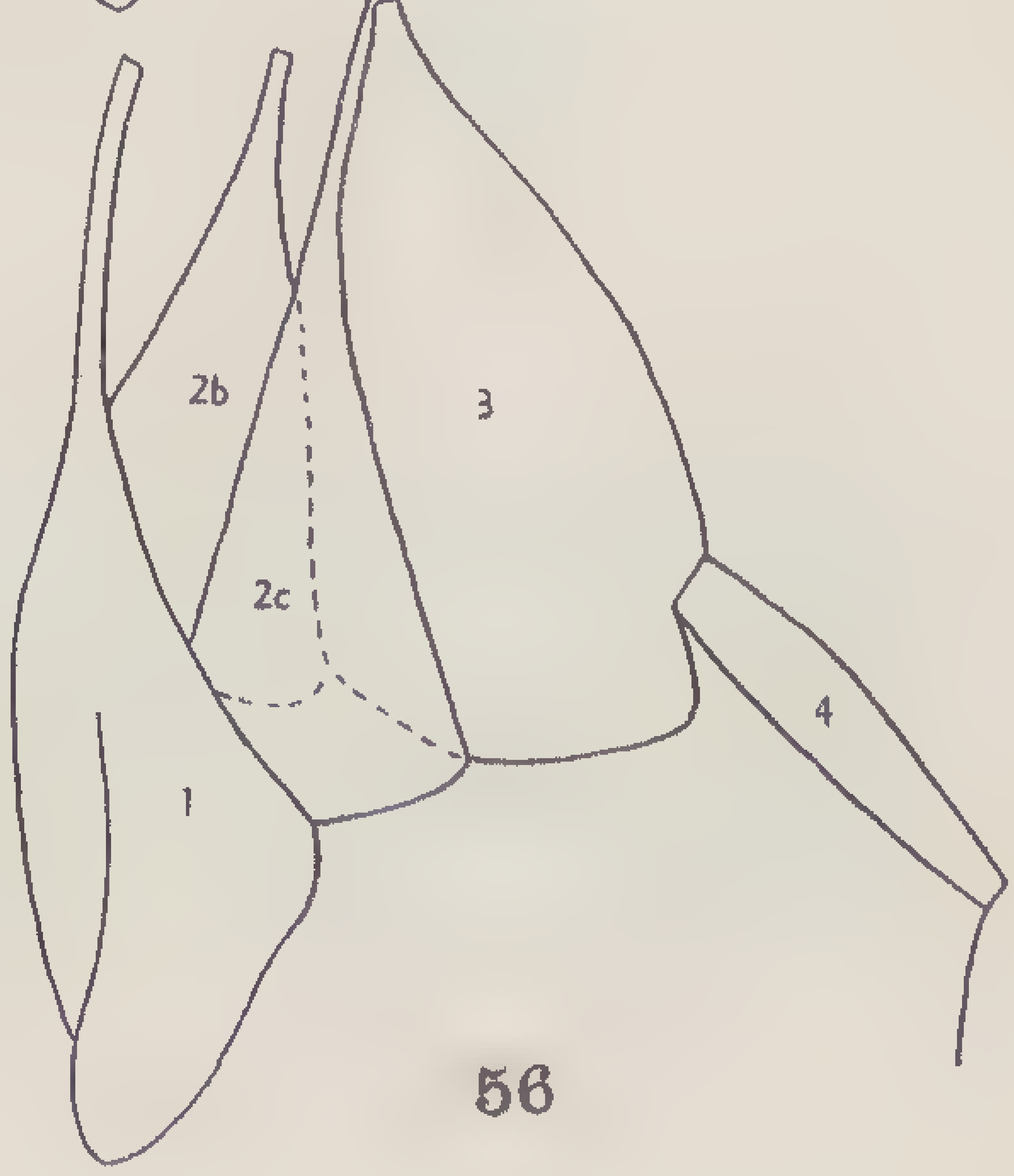
53



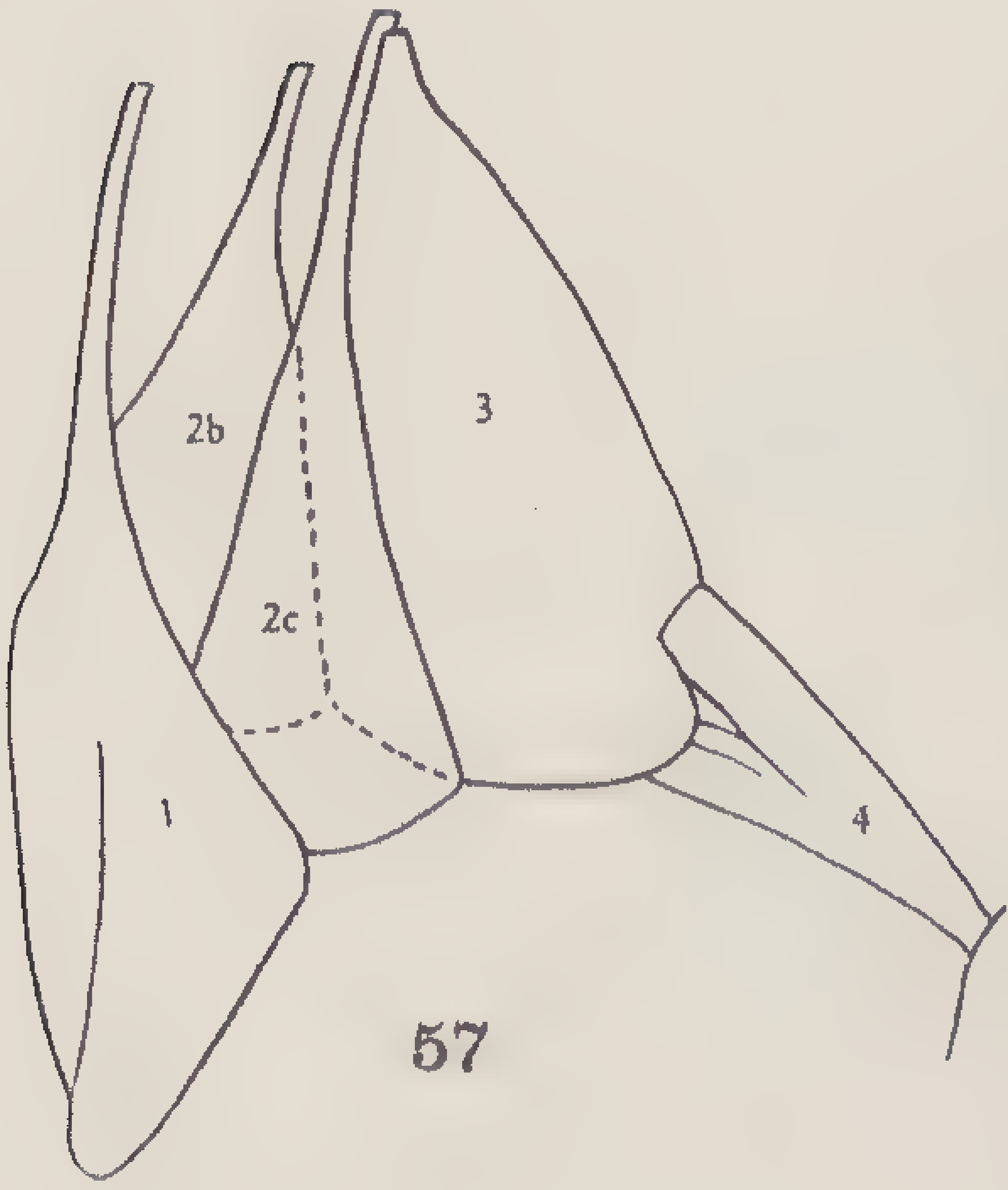
54



55



56



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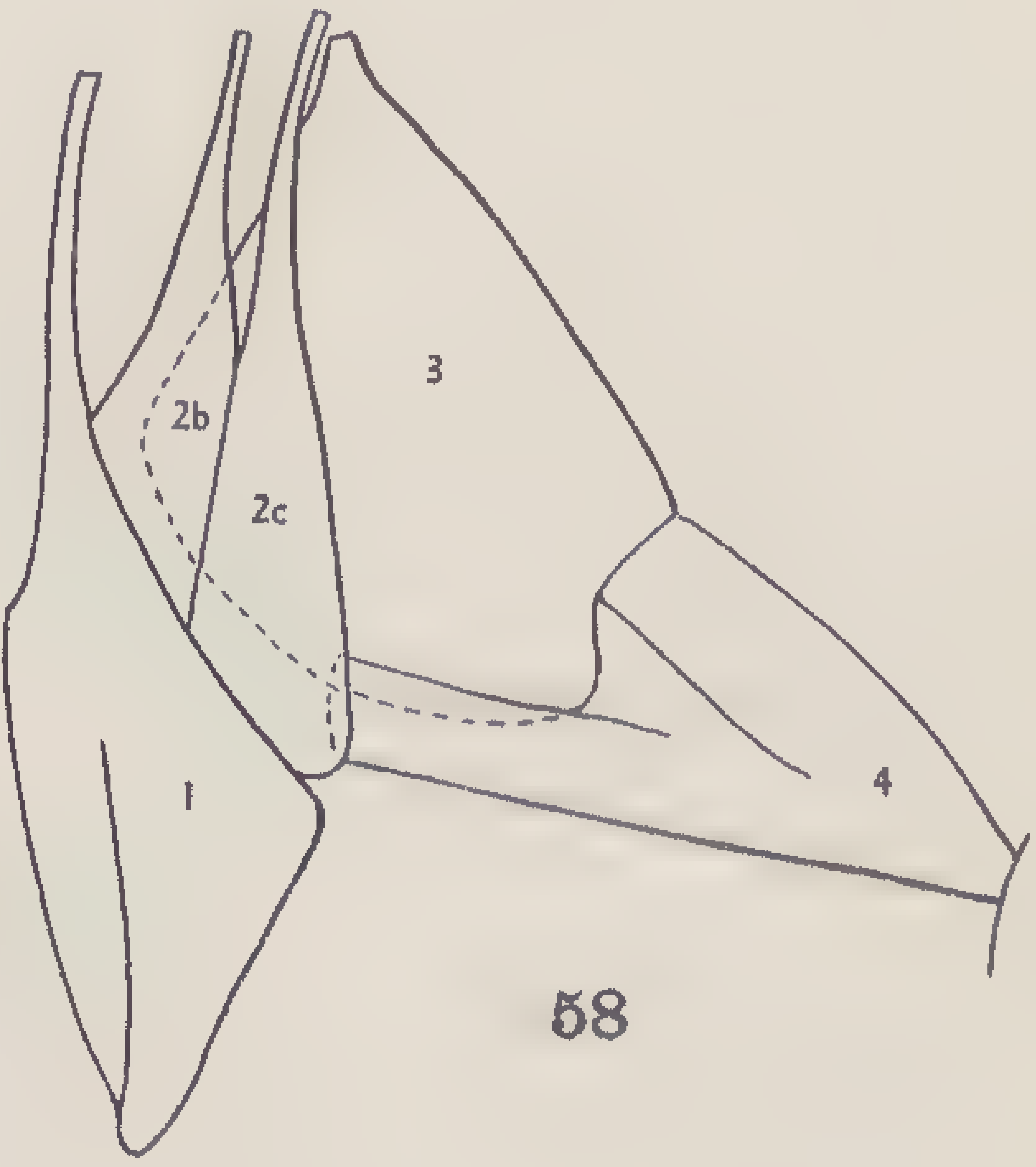


58

METATHORACIC MUSCULATURE (Left Side)

FIG. 59. *Exomalopsis* sp. (female). Median depressor of the abdomen omitted.

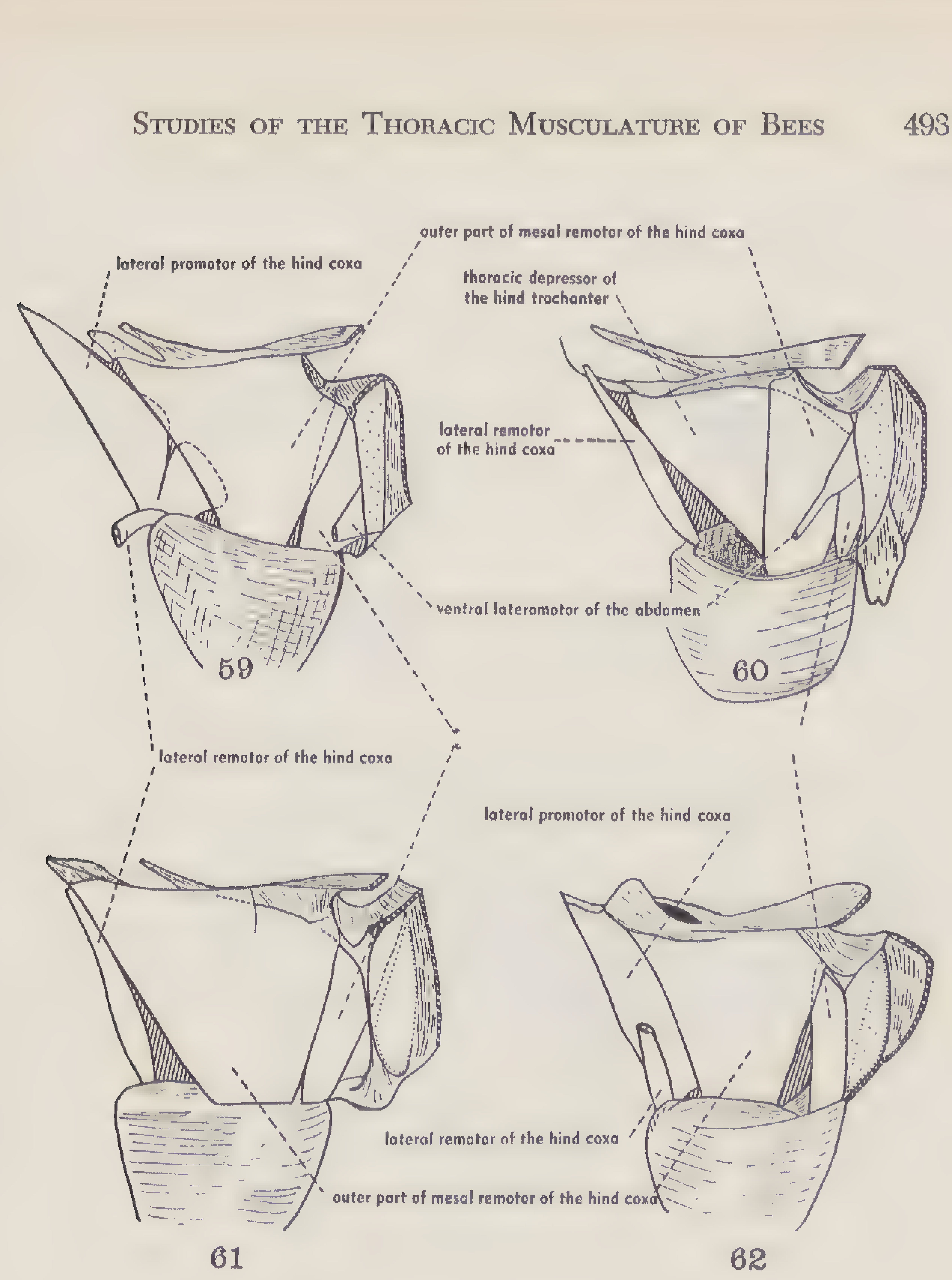
FIG. 60. *Triepeolus* sp. (female). Median depressor of the abdomen omitted.

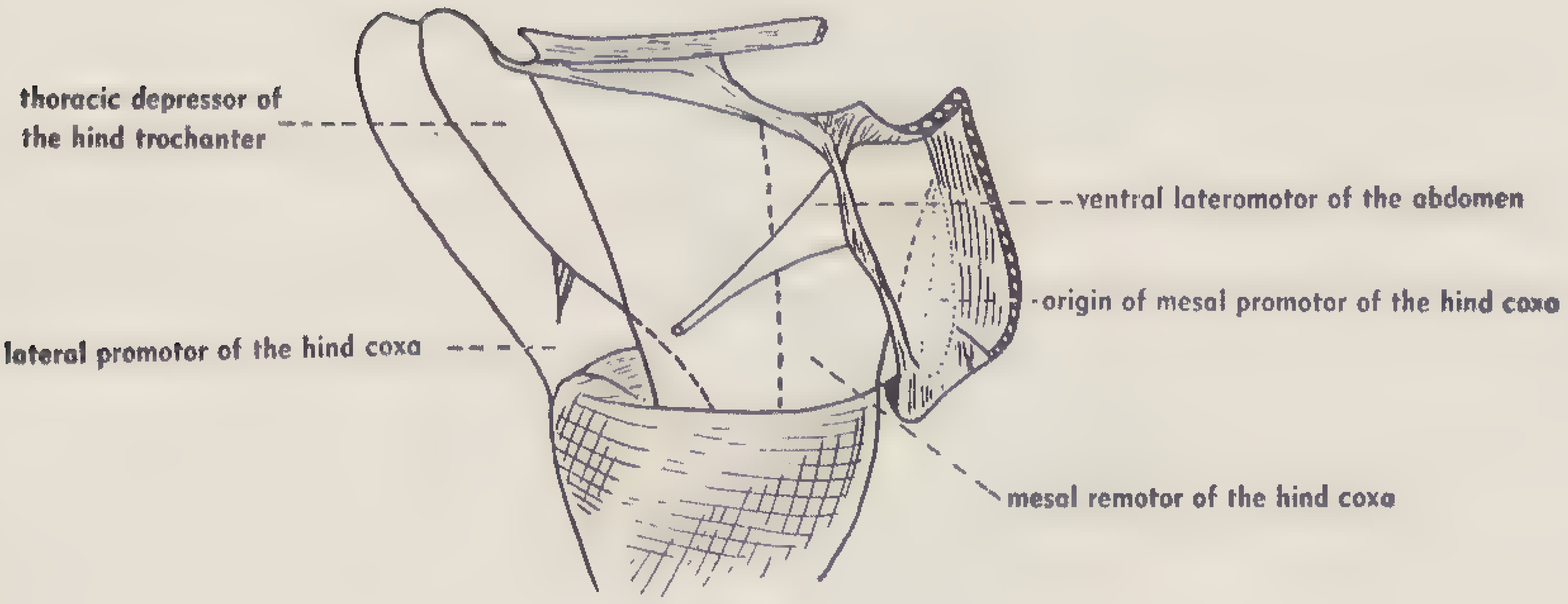
FIG. 61. *Ptilothrix sumichrastii* (female). Median depressor of the abdomen and ventral lateromotor of the abdomen omitted.

FIG. 62. *Florilegus condignus* (female). Median depressor of the abdomen and ventral lateromotor of the abdomen omitted.

FIG. 63. *Anthophora californica* (female). Median depressor of the abdomen and lateral remotor of the hind coxa omitted.

NOTE: Dotted lines connecting figures 60 and 62 refer to inner part of mesal remotor of the hind coxae.


outer part of mesal remotor of the hind coxa
lateral promotor of the hind coxa
thoracic depressor of the hind trochanter
lateral remotor of the hind coxa
ventral lateromotor of the abdomen
59
60
lateral remotor of the hind coxa
lateral promotor of the hind coxa
lateral remotor of the hind coxa
outer part of mesal remotor of the hind coxa
61
62


thoracic depressor of the hind trochanter
ventral lateromotor of the abdomen
origin of mesal promotor of the hind coxa
lateral promotor of the hind coxa
mesal remotor of the hind coxa

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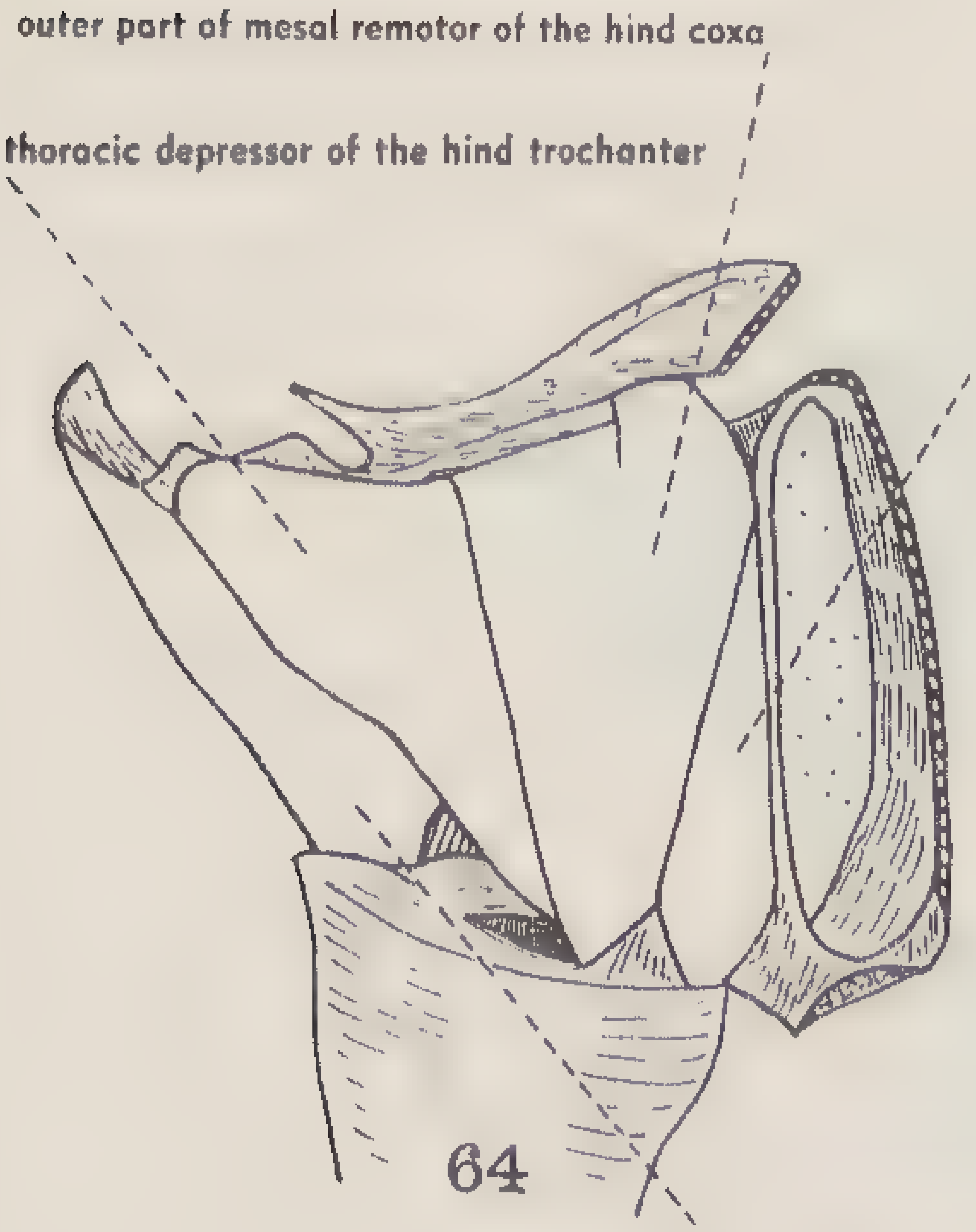
METATHORACIC MUSCULATURE (Left Side)

FIG. 64. *Centris* near *agilis* (female). Median depressor of the abdomen, ventral lateromotor of the abdomen, and lateral remotor of the hind coxa omitted.

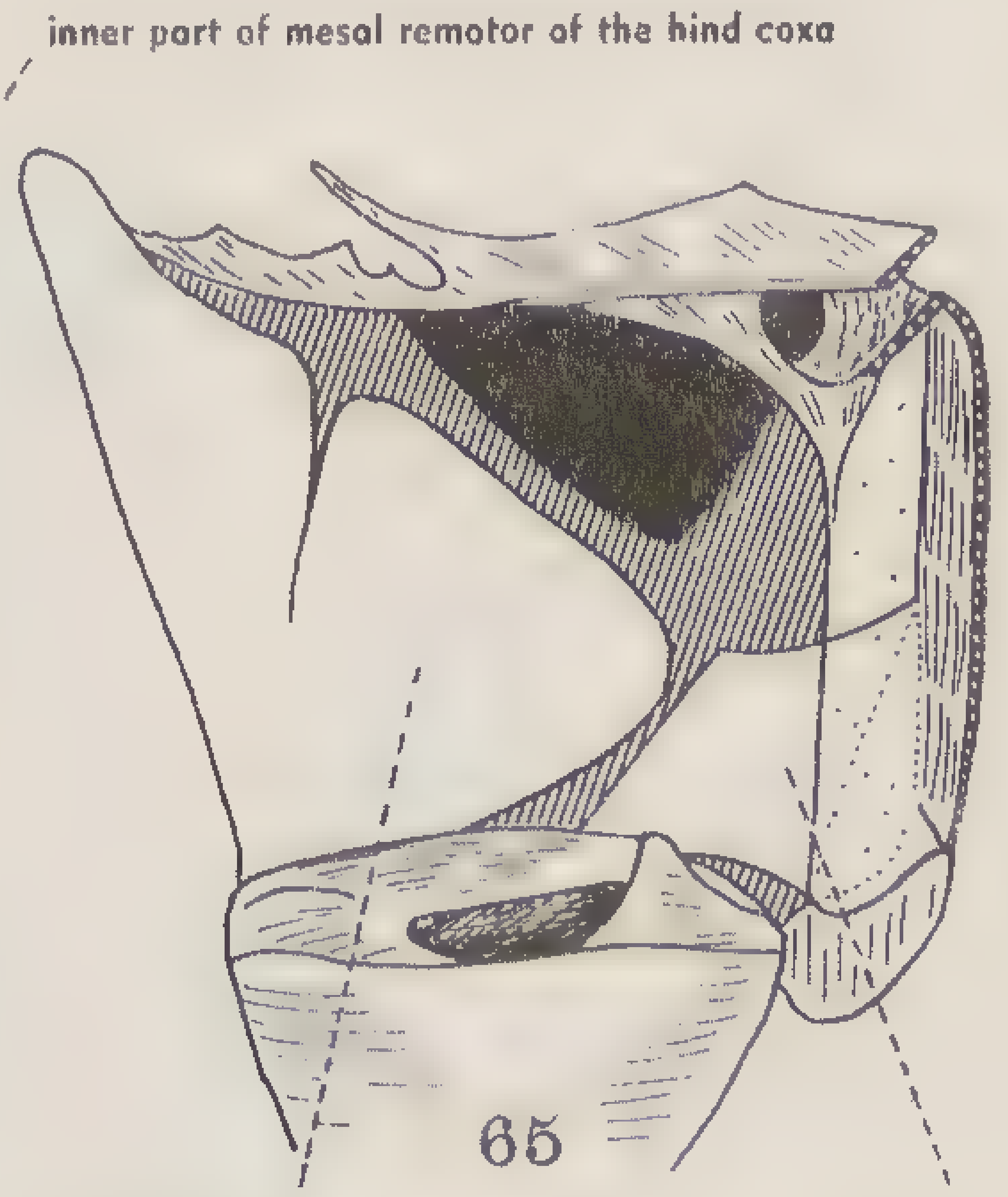
FIG. 65. *Epicharis* sp. (female). Promotors of the hind coxa.

FIG. 66. *Epicharis* sp. (female). Median depressor of the abdomen and ventral lateromotor of the abdomen omitted.

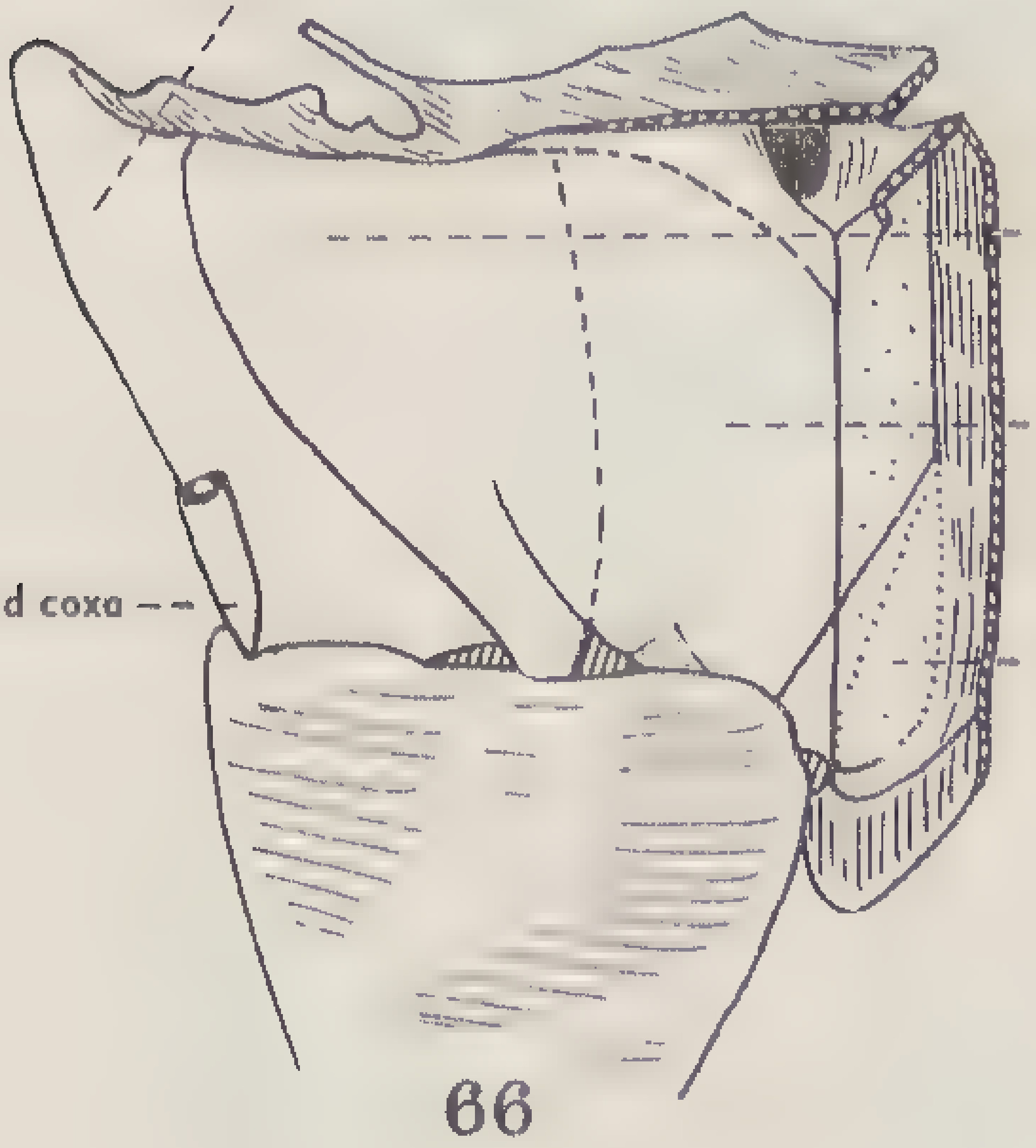
FIG. 67. *Xylocopa fimbriata* (female). Median depressor of the abdomen and ventral lateromotor of the abdomen omitted.


outer part of mesal remotor of the hind coxa
thoracic depressor of the hind trochanter

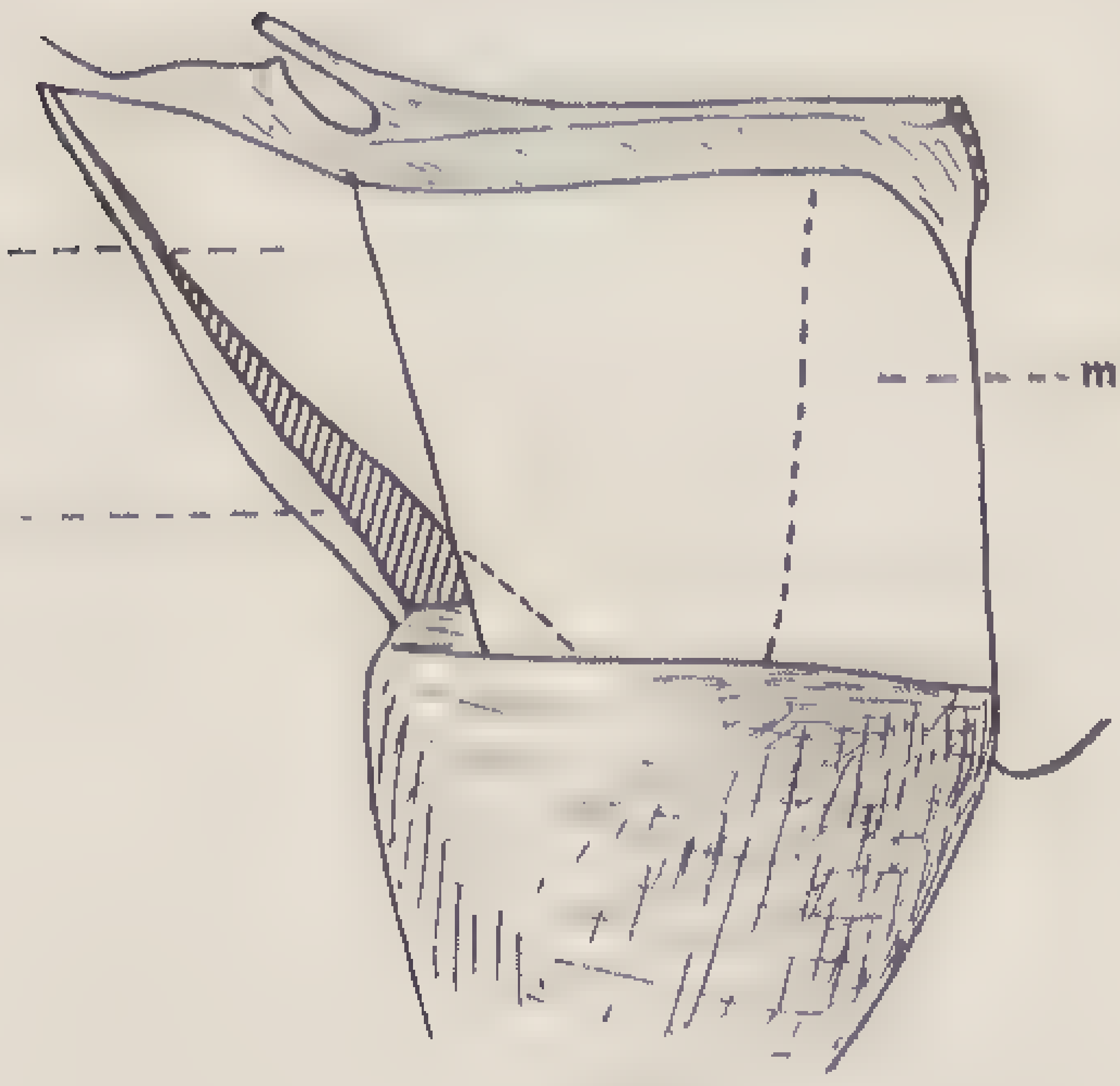
64


inner part of mesal remotor of the hind coxa
lateral promotor of the hind coxa
mesal promotor of the hind coxa

65


thoracic depressor of the hind trochanter
mesal remotor of the hind coxa
lateral remotor of the hind coxa
origin of mesal promotor of the hind coxa

66


thoracic depressor of the hind trochanter
mesal remotor of the hind coxa
lateral remotor of the hind coxa

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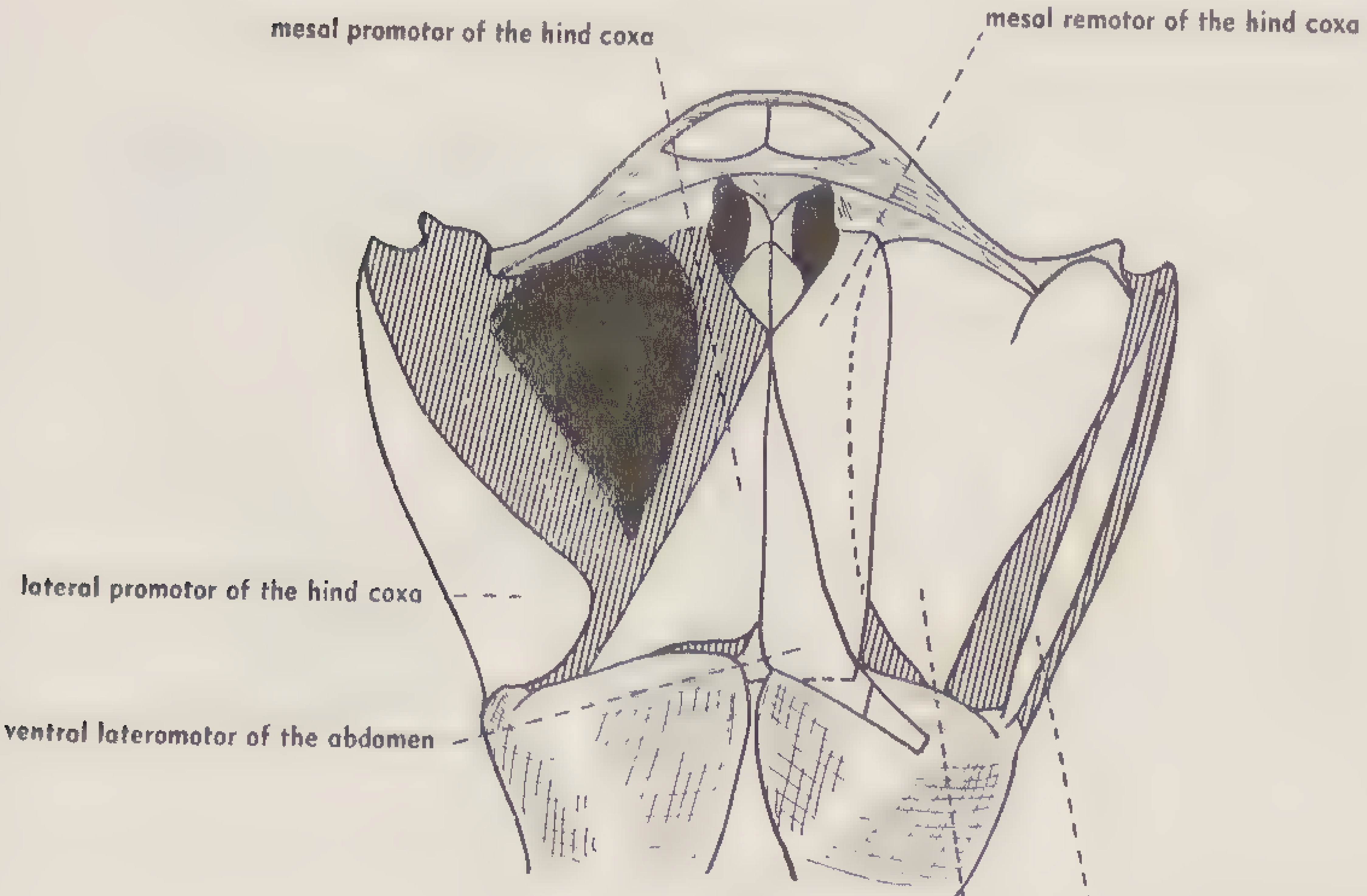
METATHORACIC MUSCULATURE

FIG. 68. *Ceratina ignara* (female). Left side: Promotors of the hind coxa. Right side: Median depressor of the abdomen omitted.

FIG. 69. *Ceratina ignara* (female).


mesal promotor of the hind coxa
mesal remotor of the hind coxa
lateral promotor of the hind coxa
ventral lateromotor of the abdomen

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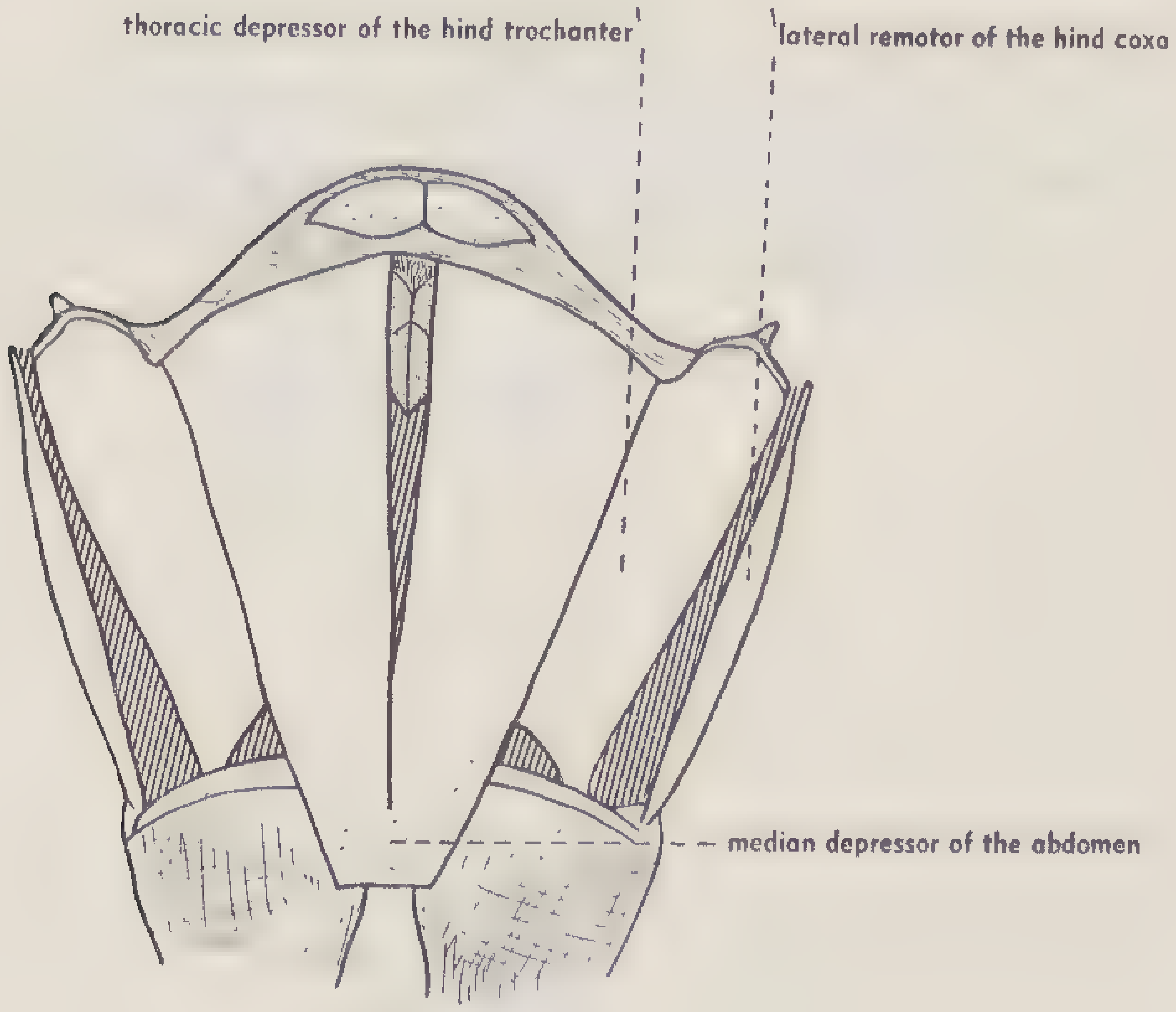
thoracic depressor of the hind trochanter
lateral remotor of the hind coxa
median depressor of the abdomen

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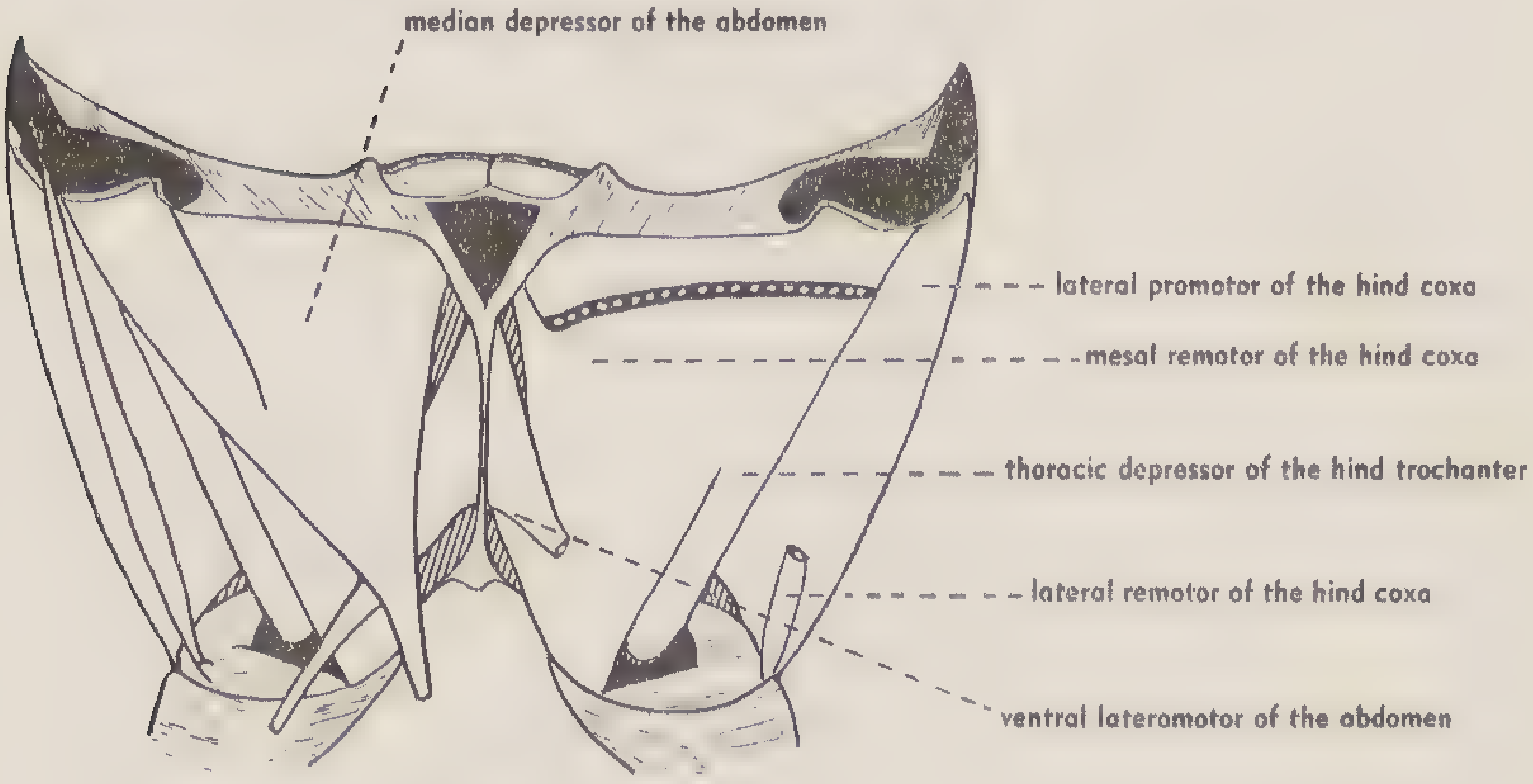
METATHORACIC MUSCULATURE

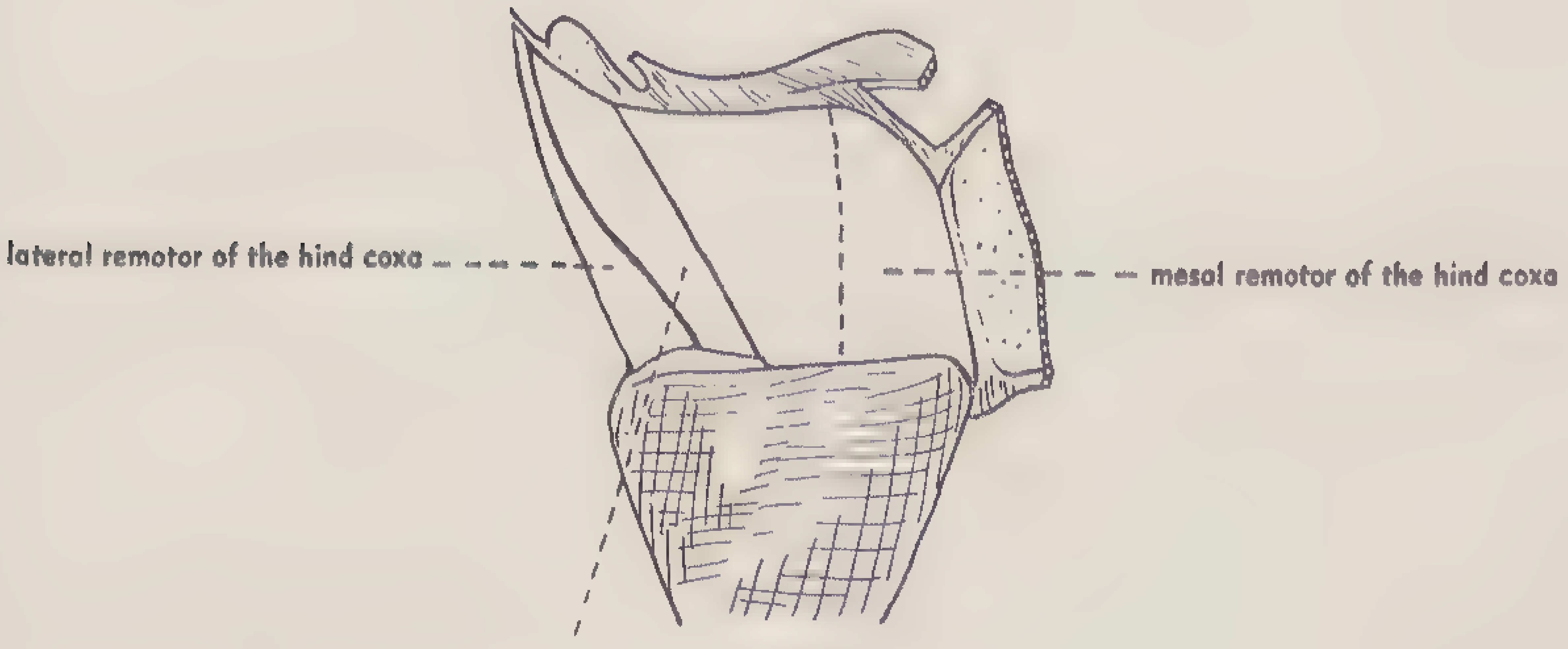
FIG. 70. *Bombus medius* (worker).

FIG. 71. *Euglossa (Euglossa)* sp. Left side: Median depressor of the abdomen and ventral lateromotor of the abdomen omitted.

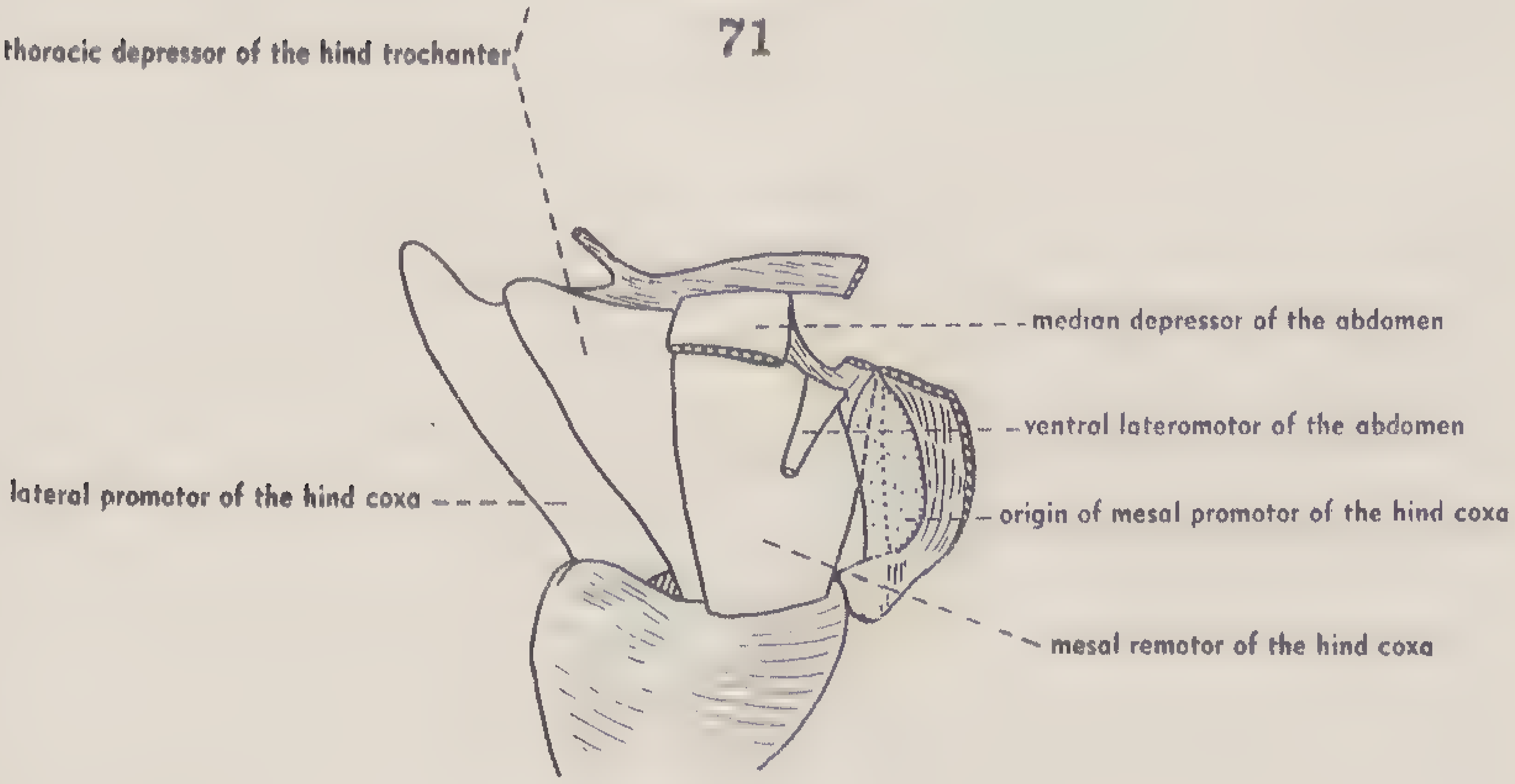
FIG. 72. *Melipona beechei.* Lateral remotor of the hind coxa omitted.


median depressor of the abdomen
lateral promotor of the hind coxa
mesal remotor of the hind coxa
thoracic depressor of the hind trochanter
lateral remotor of the hind coxa
ventral lateromotor of the abdomen

70


lateral remotor of the hind coxa
mesal remotor of the hind coxa

71


thoracic depressor of the hind trochanter
median depressor of the abdomen
ventral lateromotor of the abdomen
lateral promotor of the hind coxa
origin of mesal promotor of the hind coxa
mesal remotor of the hind coxa

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Catalogue of the Types in the Snow Entomological Museum. Part I (Hymenoptera)

BY

WALLACE E. LABERGE *

ABSTRACT: This paper is the first part of a catalogue of the type specimens in the Snow Entomological Museum of the University of Kansas. Types of 746 species of Hymenoptera are listed with references, notes on the condition of the types, and type numbers as recorded in the catalogue of the types in the Snow Entomological Museum.

INTRODUCTION

This paper contains a list of the type specimens of Hymenoptera in the Snow Entomological Museum of the University of Kansas arranged alphabetically under each family or superfamily. The types are placed in two lists beneath each family or superfamily, except in cases in which only one to three species represent the group. First, the holotypes, allotypes, cotypes and lectotypes are listed together with references to the papers in which these were originally described. Second, the paratypes are listed without references. The names and references cited in both lists have all been checked for accuracy.

The term cotype is used only in reference to a member of a syntypical series. Some authors in the past have used the term cotype as synonymous with paratype. An attempt has been made to discover all such cases and such specimens are listed as paratypes.

Since it is the hope of the author that all of the types in the Snow Museum will be catalogued in this and subsequent papers, the list contains only a minimum of information concerning the specimens. Mention is made of lost, destroyed or seriously damaged holotypes, allotypes and lectotypes. The sex, the number of type specimens, and the Snow Entomological Museum type

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* Contribution No. 916 of the Department of Entomology, University of Kansas, Lawrence, Kansas.

number, as recorded in the catalogue of types in the Snow Entomological Museum, are listed. Secondary types, such as metatypes, topotypes and homotypes, are omitted from this list and are not recorded in the catalogue of types in the Snow Entomological Museum. No notice is taken of synonymy; the genera under which the species are listed are those under which they were originally described. Lectotypes have not been designated in this catalogue, since the author is of the opinion that such designations should be made only by the author of the species in question or by some competent authority in the group involved.

ACKNOWLEDGMENTS

The author is grateful to the following persons who have graciously taken the time to answer questions regarding references to certain names: R. M. Bohart, University of California at Davis; B. D. Burks, U. S. N. M.; H. E. Evans, Cornell University; Karl V. Krombein, U. S. N. M. The author also wishes to thank the University of Kansas for providing aid from its general research fund for the purpose of cataloguing the types in the Snow Entomological Museum.

Types of 746 species, of which 373 are represented only by paratypes, are listed in this part of the catalogue.

APOIDEA

Andrena collitoides Viereck and Cockerell, 1914, Proc. U. S. Nat. Mus., vol. 48, p. 27. ♂ holotype. 4284.

Andrena kraussi Michener, 1954, Bull. Amer. Mus. Nat. Hist., vol. 104, p. 30. ♀ holotype. 4285.

Andrena submariae Viereck and Cockerell, 1914, Proc. U. S. Nat. Mus., vol. 48, p. 4. ♀ holotype. 4288.

Anthocopa beameri Michener, 1951, Pan-Pacific Ent., vol. 27, p. 64. ♀ holotype, ♂ allotype, 2 ♀ and 15 ♂ paratypes. 5293.

Anthocopa daleae Michener, 1951, Pan-Pacific Ent., vol. 27, p. 62. ♀ holotype, ♂ allotype, 2 ♀ and 1 ♂ paratypes. 4394.

Anthocopa hurdiana Michener, 1954, Pan-Pacific Ent., vol. 30, p. 47. ♀ holotype. 5295.

Anthocopa mirifica Michener, 1954, Pan-Pacific Ent., vol. 30, p. 51. ♀ holotype, 10 ♀ paratypes. 5296.

Anthocopa rubrella macswaini Michener, 1954, Pan-Pac. Ent., vol. 30, p. 45. ♀ holotype, ♂ allotype, 1 ♀ and 2 ♂ paratypes. 5298.

Anthocopa rubrella rubrior Michener, 1954, Pan-Pac. Ent., vol. 30, p. 46. ♀ holotype, ♂ allotype. 5299.

Anthocopa segregata Michener, 1954, Pan-Pac. Ent., vol. 30, p. 48. ♀ holotype. 5300.

Ashmeadiella altadenae Michener, 1936, Pan-Pac. Ent., vol. 12, p. 63. ♂ holotype. 5271.

Ashmeadiella clypeodentata simplicior Michener, 1951, Pan-Pac. Ent., vol. 27, p. 70. ♀ holotype, 1 ♀ paratype. 4275.

Ashmeadiella cockerelli Michener, 1936, Pan-Pac. Ent., vol. 12, p. 62. ♂ holotype. 5272.

Ashmeadiella gillettei rubra Michener, 1951, Pan-Pac. Ent., vol. 27, p. 67. ♀ holotype, 7 ♂ paratypes. 4269.

Ashmeadiella lateralis Michener, 1936, Pan-Pac. Ent., vol. 12, p. 60. ♂ holotype. 5270.

Ashmeadiella timberlakei Michener, 1936, Pan-Pac. Ent., vol. 12, p. 56. ♀ allotype, 3 ♀ and 3 ♂ paratypes. 4364.

Ashmeadiella truncativentris Michener, 1951, Pan-Pac. Ent., vol. 27, p. 68. 4366.

Augochlora coloradensis Titus, 1901, Canad. Ent., vol. 33, p. 133. ♀ cotype. 2223.

Ceratina glossata Michener, 1954, Bull. Amer. Mus. Nat. Hist., vol. 104, p. 150. ♀ holotype, 1 ♀ paratype. 5303.

Ceratina kraussi Michener, 1954, Bull. Amer. Mus. Nat. Hist., vol. 104, p. 153. ♀ holotype, 12 ♀ paratypes. 5304.

Ceratina nigritula Michener, 1954, Bull. Amer. Mus. Nat. Hist., vol. 104, p. 153. ♀ holotype, ♂ allotype, 1 ♂ paratype. 5305.

Ceratina rectangulifera Schwarz and Michener, 1954, Bull. Amer. Mus. Nat. Hist., vol. 104, p. 154. ♀ holotype, 11 ♀ paratypes. 5306.

Chelostoma bernardinum Michener, 1938, Pan-Pac. Ent., vol. 14, p. 40. ♂ allotype, 3 ♀ paratypes. 4319.

Chelostoma marginatum incisuloides Michener, 1954, Jour. Kansas Ent. Soc., vol. 27, p. 69. ♂ holotype, ♀ allotype. 5269.

Colletes aridus Stephen, 1954, Univ. Kansas Sci. Bull., vol. 36, p. 494. ♂ holotype, ♀ allotype, 1 ♂ and 1 ♀ paratypes. 5209.

Colletes beamerorum Stephen, 1954, Univ. Kansas Sci. Bull., vol. 36, p. 465. ♂ holotype, 5 ♂ paratypes. 5208.

Colletes bulbotibialis Stephen, 1954, Univ. Kansas Sci. Bull., vol. 36, p. 458. ♂ holotype. 5212.

Colletes fulgidus longiplumosus Stephen, 1954, Univ. Kansas Sci. Bull., vol. 36, p. 248. 5214.

Colletes kansensis Stephen, 1954, Univ. Kansas Sci. Bull., vol. 36, p. 297. ♂ holotype. 5217.

Colletes micheneri Stephen, 1954, Univ. Kansas Sci. Bull., vol. 36, p. 357. ♂ holotype, ♀ allotype. 5207.

Colletes nigrifrons Titus, 1900, Canad. Ent., vol. 32, p. 304. ♀ neotype selected by Stephen, 1954, Univ. Kansas Sci. Bull., vol. 36, p. 429. ♀ neotype, ♂ neoallotype. 5219.

Colletes punctipennis maurus Stephen, 1954, Univ. Kansas Sci. Bull., vol. 36, p. 232. ♂ holotype. 5218.

Colletes saritensis Stephen, 1954, Univ. Kansas Sci. Bull., vol. 36, p. 341. ♂ holotype, ♀ allotype, 1 ♂ and 20 ♀ paratypes. 5216.

Colletes swenki Stephen, 1954, Univ. Kansas Sci. Bull., vol. 36, p. 450. ♂ holotype, ♀ allotype, 6 ♂ and 2 ♀ paratypes. 5211.

Colletes timberlakei Stephen, 1954, Univ. Kansas Sci. Bull., vol. 36, p. 290. ♂ holotype, 1 ♂ paratype. 5210.

Diadasia afflicta perafflicta Cockerell, 1905, Amer. Nat., vol. 39, p. 744. ♂ holotype, 1 ♂ paratype. 1027.

Exomalopsis mourei Michener, 1954, Bull. Amer. Mus. Nat. Hist., vol. 104, p. 106. ♀ holotype, ♂ allotype, 35 ♀ and 18 ♂ paratypes. 5286.

Exomalopsis snowi Cockerell, 1906, Ann. Mag. Nat. Hist., ser. 7, vol. 18, p. 73. ♂ holotype. 1033.

Florilegus isthmicus Michener, 1954, Bull. Amer. Mus. Nat. Hist., vol. 104, p. 134. ♂ allotype, 1 ♀ paratype. 4393.

Halictoides altidenae Michener, 1937, Ann. Mag. Nat. Hist., ser. 10, vol. 19, p. 395. ♂ allotype, 2 ♀ paratypes. 4337.

Halictoides nemophilae Michener, 1937, Ann. Mag. Nat. Hist., ser. 10, vol. 19, p. 400. ♀ allotype, 1 ♂ and 3 ♀ paratypes. 4349.

Halictoides rhamni Michener, 1937, Ann. Mag. Nat. Hist., ser. 10, vol. 19, p. 394. ♀ allotype, 2 ♀ paratypes. 4348.

Halictus bernardinensis Michener, 1936, Ann. Mag. Nat. Hist., ser. 10, vol. 18, p. 286. ♀ holotype. 4326.

Heriades micropthalma Michener, 1954, Jour. Kansas Ent. Soc., vol. 28, p. 66. ♀ holotype, ♂ allotype, 1 ♂ and 10 ♀ paratypes. 5509.

Hesperapis parva Michener, 1937, Ann. Mag. Nat. Hist., ser. 10, vol. 19, p. 327. ♂ allotype, 1 ♂ paratype. 4352.

Hoplitis mazourka Michener, 1954, Pan-Pac. Ent., vol. 30, p. 38. ♂ holotype. 5273.

Lasioglossum kraussi Michener, 1954, Bull. Amer. Mus. Nat. Hist., vol. 104, p. 50. ♀ holotype, 1 ♀ paratype. 5264.

Lasioglossum strigosigena Michener, 1954, Bull. Amer. Mus. Nat. Hist., vol. 104, p. 47. ♀ holotype, ♂ allotype, 3 ♂ and 3 ♀ paratypes. 5265.

Leptometria pacifica Cockerell, 1914, Jour. New York Ent. Soc., vol. 22, p. 319. ♂ holotype, 2 ♀ paratypes. 4432.

Megachile gualanensis Cockerell, 1912, Ann. Mag. Nat. Hist., ser. 8, vol. 10, p. 27. ♀ holotype, 4 ♀ and 8 ♂ paratypes. 3349.

Megachile pruina nigropinguis Mitchell, 1937, Amer. Ent. Soc. Trans., vol. 63, p. 68. ♀ holotype. 1014.

Melissodes aegis LaBerge, 1956, Univ. Kansas Sci. Bull., vol. 37, p. 959. ♂ holotype, ♀ allotype, 3 ♂ and 4 ♀ paratypes. 4430.

Melissodes atripes atrimitra LaBerge, 1956, Univ. Kansas Sci. Bull., vol. 37, p. 949. ♂ holotype, ♀ allotype, 8 ♂ and 1 ♀ paratypes. 4431.

Melissodes bimaculata nulla LaBerge, 1956, Univ. Kansas Sci. Bull., vol. 37, p. 1109. ♂ holotype, ♀ allotype, 4 ♂ and 5 ♀ paratypes. 5221.

Melissodes blanda LaBerge, 1956, Univ. Kansas Sci. Bull., vol. 37, p. 1084. ♂ holotype, ♀ allotype, 6 ♂ paratypes. 5220.

Melissodes cubensis LaBerge, 1956, Univ. Kansas Sci. Bull., vol. 37, p. 1078. ♂ holotype, 1 ♂ paratype. 4415.

Melissodes duplocincta Cockerell, 1905, Psyche, vol. 12, p. 103. Lectotypes designated by LaBerge, 1956, Univ. Kansas Sci. Bull., vol. 37, p. 1031. ♂ lectotype, ♀ lectoallotype. 1015.

Melissodes elusa LaBerge, 1956, Univ. Kansas Sci. Bull., vol. 37, p. 1061. ♂ holotype, ♀ allotype, 1 ♀ and 10 ♂ paratypes. 4440.

Melissodes epicharina Cockerell, 1905, Psyche, vol. 12, p. 99. ♀ holotype. 1016.

Melissodes flexa LaBerge, 1956, Univ. Kansas Sci. Bull., vol. 37, p. 1064. ♂ holotype, 3 ♂ paratypes. 4455.

Melissodes galvestonensis Cockerell, 1905, Proc. Biol. Soc. Washington, vol. 18, p. 181. Lectotypes designated by LaBerge, 1956, Univ. Kansas Sci. Bull., vol 37, p. 1135. ♀ lectotype, ♂ lectoallotype. 1017.

Melissodes gilensis crenata LaBerge, 1956, Univ. Kansas Sci. Bull., vol. 37, p. 1150. ♂ holotype, ♀ allotype, 5 ♂ and 9 ♀ paratypes. 5500.

Melissodes herricki Cockerell, 1905, Psyche, vol. 12, p. 98. ♀ cotype, ♂ cotype. 1018.

Melissodes hexacantha Cockerell, 1905, Psyche, vol. 12, p. 100. ♂ holotype. 1019.

Melissodes hortivagans Cockerell, 1905. Proc. Biol. Soc. Washington, vol. 18, p. 180. ♂ holotype. 1020.

Melissodes minima LaBerge, 1956, Univ. Kansas Sci. Bull., vol. 37, p. 931. ♂ holotype, ♀ allotype, 8 ♂ paratypes. 4274.

Melissodes nigrosignata Cockerell, 1905, Psyche, vol. 12, p. 101. ♀ holotype. 1021.

Melissodes nigrosignata pallidisignata Cockerell, 1905, Proc. Biol. Soc. Washington, vol. 18, p. 180. ♀ holotype. 1022.

Melissodes nitida LaBerge, 1956, Univ. Kansas Sci. Bull., vol. 37, p. 969. ♂ holotype, ♀ allotype, 2 ♂ paratypes. 5502.

Melissodes praelauta Cockerell, 1905, Psyche, vol. 12, p. 102. ♂ holotype. 1023.

Melissodes semitristis Cockerell, 1905, Psyche, vol. 12, p. 102. ♂ holotype. 1024.

Melissodes sila LaBerge, 1956, Univ. Kansas Sci. Bull., vol. 37, p. 1002. ♂ holotype, ♀ allotype, 3 ♂ and 4 ♀ paratypes. 5504.

Melissodes tenuitarsis Cockerell, 1905, Psyche, vol. 12, p. 99. ♂ holotype. 1025.

Melissodes tepida yumensis LaBerge, 1956, Univ. Kansas Sci. Bull., vol. 37, p. 1128. ♂ holotype, ♀ allotype, 2 ♂ and 8 ♀ paratypes. 5508.

Melissodes tessellata LaBerge, 1956, Univ. Kansas Sci. Bull., vol. 37, p. 1157. ♂ holotype, ♀ allotype, 36 ♂ and 19 ♀ paratypes, 5505.

Melissodes thelypodii stulta LaBerge, 1956, Univ. Kansas Sci. Bull.. vol. 37, p. 1073. ♂ holotype, ♀ allotype, 4 ♂ and 3 ♀ paratypes. 5506.

Neocorynura nuda Michener, 1954, Bull. Amer. Mus. Nat. Hist., vol. 104, p. 81. ♀ holotype. 5257.

Neopasites carinatus Linsley, 1943, Trans. Amer. Ent. Soc., vol. 69, p. 137. ♀ holotype. 3450.

Nomadopsis fracta Rozen, 1952, Jour. Kansas Ent. Soc., vol. 25, p. 144. ♂ holotype, ♀ allotype, 24 ♂ and 36 ♀ paratypes. 5206.

Osmia calcarata White, 1952, Univ. Kansas Sci. Bull., vol. 35, p. 245. ♂ holotype, ♀ allotype, 3 ♂ and 3 ♀ paratypes. 4490.

Osmia crenulaticornis Michener, 1936, Southern California Acad. Sci. Bull., vol. 35, p. 84. ♂ holotype. 4491.

Osmia elongata Michener, 1936, Canad. Ent., vol. 68, p. 41. ♀ holotype. 5279.

Osmia hurdi White, 1952, Univ. Kansas Sci. Bull., vol. 35, p. 273. ♀ holotype, 14 ♀ paratypes. 4493.

Osmia integra nigrigena Michener, 1936, Bull. Southern California Acad. Sci., vol. 35, p. 90. ♂ holotype. 4494.

Osmia obliqua White, 1952, Univ. Kansas Sci. Bull., vol. 35, p. 238. ♂ holotype, 8 ♂ paratypes. 4489.

Panurginus bilobatus Michener, 1937, Ann. Mag. Nat. Hist., ser. 10, vol. 19, p. 322. ♀ allotype, 4 ♀ and 3 ♂ paratypes. 4293.

Perdita bidenticauda Timberlake, 1953, Univ. Kansas Sci. Bull., vol. 35, p. 965. ♂ holotype, ♀ allotype, 3 ♂ and 1 ♀ paratypes. 5230.

Perdita coreopsidis kansensis Timberlake, 1953, Univ. Kansas Sci. Bull., vol. 35, p. 984. ♀ holotype, ♂ allotype, 1 ♀ and 1 ♂ paratypes. 5231.

Perdita coreopsidis obscurior Timberlake, 1953, Univ. Kansas Sci. Bull., vol. 35, p. 984. ♀ holotype, ♂ allotype, 21 ♀ and 65 ♂ paratypes. 5232.

Perdita fracticincta Timberlake, 1953, Univ. Kansas Sci. Bull., vol. 35, p. 976. ♀ holotype. 5234.

Perdita laticauda Timberlake, 1953, Univ. Kansas Sci. Bull., vol. 35, p. 967. ♂ holotype, ♀ allotype, 10 ♂ and 12 ♀ paratypes. 5238.

Perdita lepachidis levifrons Timberlake, 1953, Univ. Kansas Sci. Bull., vol. 35, p. 983. ♀ holotype, ♂ allotype, 8 ♀ and 3 ♂ paratypes. 5237.

Perdita lobata Timberlake, 1953, Univ. Kansas Sci. Bull., vol. 35, p. 967. ♂ holotype. 5224.

Perdita peculiaris Timberlake, 1953, Univ. Kansas Sci. Bull., vol. 35, p. 970. ♂ holotype. 5227.

Perdita perpulchra flavidior Timberlake, 1953, Univ. Kansas Sci. Bull., vol. 35, p. 975. ♀ holotype. 5238.

Perdita scopata Timberlake, 1953, Univ. Kansas Sci. Bull., vol. 35, p. 980. ♀ holotype, ♂ allotype, 39 ♀ and 95 ♂ paratypes. 5241.

Perdita tricincta Timberlake, 1953, Univ. Kansas Sci. Bull., vol. 35, p. 978. ♀ holotype, ♂ allotype, 28 ♀ and 40 ♂ paratypes. 5242.

Perdita trifasciata Timberlake, 1953, Univ. Kansas Sci. Bull., vol. 35, p. 969. ♂ holotype. 5243.

Perdita verbesinae nigrior Cockerell, 1896, Proc. Acad. Sci. Philadelphia, vol. 48, p. 102. ♀ holotype. 4307.

Proteriades bidenticauda Timberlake and Michener, 1950, Univ. Kansas Sci. Bull., vol. 33, p. 420. ♂ holotype, ♀ allotype, 6 ♀ and 16 ♂ paratypes. 4377.

Proteriades caudex Timberlake and Michener, 1950, Univ. Kansas Sci. Bull., vol. 33, p. 418. ♂ holotype, ♀ allotype, 6 ♀ and 8 ♂ paratypes. 4378.

Proteriades hamulicornis Timberlake and Michener, 1950, Univ. Kansas Sci. Bull., vol. 33, p. 425. ♂ holotype, ♀ allotype. 5274.

Proteriades incanescens tota Michener, 1954, Jour. Kansas Ent. Soc., vol. 27, p. 72. ♀ holotype. 5275.

Proteriades nanula sparsa Timberlake and Michener, 1950, Univ. Kansas Sci. Bull., vol. 33, p. 410. ♂ holotype, ♀ allotype, 2 ♂ and 5 ♀ paratypes. 4382.

Proteriades nigrella attonita Michener, 1954, Jour. Kansas Ent. Soc., vol. 27, p. 73. ♀ holotype, ♂ allotype. 5277.

Proteriades truicauda Timberlake and Michener, 1950, Univ. Kansas Sci. Bull., vol. 33, p. 423. ♂ holotype, ♀ allotype, 1 ♂ and 1 ♀ paratypes. 4386.

Psithyrus consultus Franklin, 1913, Trans. Amer. Ent. Soc., vol. 38, p. 459. 2 ♂ cotypes. 1035.

Psithyrus tricolor Franklin, 1911, Trans. Amer. Ent. Soc., vol. 37, p. 167. 1 ♂ cotype. 1034.

Spinoliella lawae Michener, 1937, Ann. Mag. Nat. Hist., ser. 10, vol. 19, p. 324. ♀ holotype. 4533.

Synhalonia fuscotincta Cockerell, 1905, Proc. Biol. Soc. Washington, vol. 18, p. 178. ♀ holotype. 1029.

Synhalonia gillettei snoviana Cockerell, 1905, Proc. Biol. Soc. Washington, vol. 18, p. 179. ♂ holotype. 1028.

Synhalonia lippiae semilippiae Cockerell, 1905, Proc. Biol. Soc. Washington, vol. 18, p. 179. ♀ holotype. 1030.

Trigona acapulconis kraussi Schwarz, 1951, Amer. Mus. Nov., no. 1505, p. 8. ♀ holotype, 1 ♀ paratype. 4458.

Trophocleptria schrederi Michener, 1954, Bull. Amer. Mus. Nat. Hist., vol. 104, p. 127. ♀ holotype. 5291.

Xenoglossa angelica Cockerell, 1902, Ent. News, vol. 13, p. 103. ♂ cotype. 4435.

Xenoglossa pruinosa limitaris Cockerell, 1906, Ann. Mag. Nat. Hist., ser. 7, vol. 18, p. 73. ♂ holotype. 1031.

Xenoglossa strenua kansensis Cockerell, 1905, Psyche, vol. 12, p. 104. ♂ holotype, 1 ♂ paratype. 1032.

Xenopanurgus readioi Michener, 1952, Jour. Kansas Ent. Soc., vol. 25, p. 25. ♂ holotype. 4532.

APOIDEA—Paratypes

Ancyloscelis hertigi Michener. 3 ♂, 8 ♀. 5282.
Ancyloscelis panamensis Michener. 10 ♂, 23 ♀. 5283.
Andrena duboisi Timberlake, 1 ♂, 1 ♀. 4355.
Andrena lativentris Timberlake. 1 ♀. 4416.
Andrena nigroclypeata Linsley. 2 ♂, 2 ♀. 5203.
Andrena sieverti opacicauda Cockerell. 1 ♀. 4289.
Andrena submaura Linsley. 1 ♀. 4287.
Andrena vanduzeei Linsley. 1 ♀. 5205.
Andrena vidalesi panamensis Michener. 1 ♂, 11 ♀. 5204.
Anthocopa alta Michener. 2 ♀. 4390.
Anthocopa anthodyta Michener. 6 ♂. 4391.
Anthocopa anthodyta bequaerti Michener. 1 ♂, 1 ♀. 4392.
Anthocopa arizonensis Michener. 1 ♀. 5278.
Anthocopa namatophila Michener. 1 ♂. 5297.
Anthocopa nigrior Michener. 1 ♂. 4396.
Anthocopa nitidivitta Michener. 1 ♂, 2 ♀. 4397.
Anthocopa oregona Michener. 1 ♂, 1 ♀. 4398.
Anthocopa panamintensis Michener. 4 ♂, 1 ♀. 4399.
Anthocopa pycnognatha Michener. 4 ♂. 4400.
Anthocopa pycnognatha solatus Michener. 2 ♂, 2 ♀. 4401.
Anthocopa rubrella Michener. 1 ♂, 1 ♀. 4402.
Anthocopa triodonta usingeri Michener. 3 ♂, 5 ♀. 4403.
Anthophora emarginata Timberlake. 1 ♂, 3 ♀. 4443.
Anthophora erythrothorax Michener. 1 ♀. 4444.
Anthophora gohrmanae coloradensis Michener. 1 ♂, 1 ♀. 4445.
Anthophora langi Cockerell. 1 ♂. 4446.
Anthophora rhodothorax Michener. 1 ♂, 1 ♀. 4447.
Anthophora simillima californiensis Michener. 1 ♂. 4448.
Anthophora subspensis Cockerell. 1 ♂. 4291.
Ashmeadiella barberi Michener. 1 ♂. 4276.
Ashmeadiella basalis Michener. 7 ♂, 2 ♀. 4280.
Ashmeadiella basalis nigra Michener. 1 ♀. 4358.
Ashmeadiella breviceps Michener. 3 ♀. 4282.
Ashmeadiella cactorum astragali Michener. 10 ♂, 50 ♀. 2578.
Ashmeadiella cactorum Cockerell. 1 ♀. 4277.
Ashmeadiella californica sierraensis Michener. 1 ♀. 4278.
Ashmeadiella cazieri Michener. 1 ♀. 4279.
Ashmeadiella difugita emarginatula Michener. 3 ♀. 4474.
Ashmeadiella erema Michener. 2 ♀. 4281.
Ashmeadiella eurynorhyncha Michener. 2 ♂, 3 ♀. 4273.

Ashmeadiella florissantensis Michener. 1 ♂, 1 ♀. 4272.
Ashmeadiella foxiella Michener. 1 ♂. 4271.
Ashmeadiella gillettei cismontanica Michener. 2 ♀. 4334.
Ashmeadiella inyoensis Michener. 3 ♂, 6 ♀. 4356.
Ashmeadiella maxima Michener. 1 ♀. 4357.
Ashmeadiella occipitalis Michener. 1 ♂, 1 ♀. 4359.
Ashmeadiella rufitarsis Michener. 1 ♂, 1 ♀. 4360.
Ashmeadiella rufiventris Michener. 1 ♀. 4361.
Ashmeadiella salviae Michener. 3 ♂, 6 ♀. 4362.
Ashmeadiella submaxima Michener. 1 ♂. 4363.
Ashmeadiella timberlakei salida Michener. 7 ♂, 3 ♀. 4365.
Ashmeadiella xenomastax Michener. 3 ♀. 4367.
Augochlora antonita Michener. 5 ♂, 2 ♀. 5251.
Augochlora chiriquiana Michener. 2 ♂. 5253.
Augochlora clarki Michener. 3 ♂, 34 ♀. 5254.
Augochlora hallimani Michener. 2 ♀. 5255.
Augochlora mulleri mourei Michener. 1 ♀. 5256.
Augochlora quiriquensis Cockerell. 1 ♀. 4315.
Augochlora utahensis Michener. 1 ♀. 4314.
Augochlorella bidentata Michener. 2 ♂, 9 ♀. 5252.
Augochlorella edentata Michener. 1 ♀. 5262.
Augochloropsis auriferina Michener. 1 ♀. 5247.
Augochloropsis crassiceps Moure. 1 ♀. 5248.
Augochloropsis fairchildi Michener. 5 ♀. 5249.
Augochloropsis hebescens fuscocyanea Michener. 1 ♀. 5250.
Caenaugochlora macswaini Michener. 2 ♂. 5261.
Calliopsis anomoptera Michener. 1 ♂, 1 ♀. 4308.
Calliopsis bernardinensis Michener. 7 ♂, 3 ♀. 4309.
Centris obscurior Michener. 17 ♂, 3 ♀. 5301.
Ceratina breviceps Michener. 4 ♂, 2 ♀. 5302.
Ceratina nanula rigdenae Michener. 4 ♂, 5 ♀. 4450.
Ceratina sequoiae Michener. 5 ♀. 4451.
Ceratina subpunctigena Michener. 5 ♀. 4452.
Ceratina tricolor Michener. 2 ♂, 5 ♀. 5307.
Chelostoma minutum cockerelli Michener. 3 ♂, 2 ♀. 4321.
Chelostoma minutum incisulum Michener. 2 ♂. 4320.
Chelostoma minutum marginatum Michener. 4 ♂, 2 ♀. 4322.
Chelostoma phacelia Michener. 6 ♂, 4 ♀. 4330.
Chelostoma tetramerum Michener. 1 ♂. 4331.
Colletes algarobiae Cockerell. 1 ♂. 5499.
Colletes arizonensis Stephen. 1 ♂. 5215.
Colletes brimleyi Mitchell. 4 ♂. 5198.

Colletes bryanti Timberlake. 1 ♂. 5222.
Colletes carolinus Mitchell. 2 ♀. 5199.
Colletes covilleae Timberlake. 1 ♂. 5192.
Colletes deserticola Timberlake. 2 ♂, 2 ♀. 5191.
Colletes hyalinus oregonensis Timberlake. 4 ♀. 5196.
Colletes ilicis Mitchell. 2 ♂, 2 ♀. 5183.
Colletes laticinctus Timberlake. 1 ♀. 5193.
Colletes lutzi interior Timberlake. 1 ♂. 5184.
Colletes lutzi Timberlake. 1 ♂, 1 ♀. 5185.
Colletes lutzi monticola Timberlake. 2 ♂. 5186.
Colletes pinorum Timberlake. 1 ♀. 5187.
Colletes mitchelli Stephen. 2 ♂, 1 ♀. 5213.
Colletes panamensis Michener. 1 ♂, 1 ♀. 5200.
Colletes paniscus mertensiae Timberlake. 1 ♂, 1 ♀. 5190.
Colletes rugicollis nigrior Michener. 2 ♂, 1 ♀. 5201.
Colletes sphaeralceae Timberlake. 6 ♂, 6 ♀. 5188.
Colletes susannae Swenk. 1 ♂. 5197.
Colletes tectiventris Timberlake. 5 ♂, 9 ♀. 5194.
Colletes thysanellae Mitchell. 1 ♂, 1 ♀. 5195.
Diadasia lutzi Cockerell. 1 ♂, 1 ♀. 4434.
Dianthidium subrufulum Timberlake. 1 ♂. 5189.
Dufourea cuprea Bohart. 1 ♂, 1 ♀. 4339.
Dufourea dentipes Bohart. 1 ♂. 4340.
Dufourea femorata Bohart, 1 ♂, 1 ♀. 4342.
Dufourea nudicornis Timberlake. 1 ♂. 5267.
Dufourea trochantera Bohart. 1 ♀. 4344.
Dufourea tuolumne Bohart. 1 ♂, 1 ♀. 4345.
Dufourea vanduzeei Bohart. 1 ♂, 1 ♀. 4343.
Epeolus ainsliei Crawford. 1 ♂. 4428.
Exomalopsis albata Timberlake. 2 ♀. 5285.
Exomalopsis compactula completa Cockerell. 1 ♀. 4417.
Fiorentinia lanei Moure. 1 ♀. 5284.
Halictoides escholtziae Michener. 1 ♂. 4341.
Halictoides ruficaudus Michener. 7 ♀. 4347.
Halictoides sandhouseae Michner. 1 ♂, 3 ♀. 4346.
Halictus abanci Crawford. 1 ♀. 4323.
Halictus abietum Michener. 1 ♂, 2 ♀. 4324.
Halictus albuquerquensis Michener. 2 ♀. 4325.
Halictus brimleyi Crawford. 1 ♀. 4317.
Halictus brycinci Crawford. 1 ♀. 4327.
Halictus euryceps Ellis. 2 ♀. 4328.

Halictus marinensis Michener. 1 ♀. 4329.
Halictus pasadenae Michener. 2 ♂, 20 ♀. 4332.
Halictus sequoiae Michener. 2 ♀. 4333.
Heriades communis Cockerell. 1 ♀. 4298.
Heriades cressoni Michener. 3 ♂, 6 ♀. 4350.
Heriades occidentalis Michener. 3 ♂, 2 ♀. 4335.
Heriades timberlakei Michener. 3 ♂. 4336.
Hesperapis arida Michener. 16 ♂, 1 ♀. 4351.
Hesperonomada melanantha Linsley. 1 ♂, 1 ♀. 4418.
Heteranthidium cordaticeps Michener. 1 ♀. 4353.
Heteranthidium zebratum mississippi Michener. 1 ♂, 1 ♀. 4354.
Hexepeolus mojavensis Linsley. 2 ♂, 1 ♀. 4421.
Hoplitis bunocephala Michener. 1 ♂. 4370.
Hoplitis bullifacies Michener. 1 ♀. 4369.
Hoplitis elongaticeps Michener. 1 ♀. 4371.
Hoplitis paroselae Michener. 1 ♀. 4368.
Hoplitis producta bernardina Michener. 1 ♂. 4373.
Hoplitis producta panamintana Michener. 1 ♂. 4374.
Hylaeus panamensis Michener. 1 ♀. 5202.
Hypomacrotera andradensis Cockerell. 2 ♂, 2 ♀. 4310.
Lasioglossum denticeps Michener. 2 ♀. 5263.
Megachile monardarum Cockerell. 1 ♀. 4413.
Megachile manardarum Cockerell. 1 ♀. 4413.
Megachile soledadensis Cockerell. 1 ♂. 4414.
Melipona fasciata paraensis guerreroensis Schwarz. 1 ♀. 4454.
Melipona lateralis kangarumensis Cockerell. 1 ♀. 4456.
Melipona marginata micheneri Schwarz. 1 ♀. 4283.
Melissodes confusiformis incondita Cockerell. 1 ♀. 4439.
Melissodes maesta LaBerge. 1 ♂, 1 ♀. 5501.
Melissodes sabinensis Cockerell. 1 ♂. 4441.
Melissodes sabinensis nubila LaBerge. 10 ♂, 2 ♀. 5503.
Melissodes texana eluta LaBerge. 3 ♂, 2 ♀. 5507.
Melissodes toluca Cresson. 2 ♀. 5281.
Neocorynura perpectinata Michener. 3 ♀. 5258.
Neocorynura rufa Michener. 1 ♂, 1 ♀. 5259.
Neocorynura villosissima Michener. 2 ♂, 2 ♀. 5260.
Neolarra abdominalis Michener. 1 ♀. 4423.
Neolarra californica Michener. 1 ♂, 1 ♀. 4424.
Neolarra coloradensis Michener. 4 ♀. 4425.
Neolarra vandykei Michener. 4 ♀. 4426.
Nomada pallidelutea Swenk. 1 ♂. 4419.

Nomada panamensis Michener. 1 ♂. 5287.
Nomada simplicocoxa Swenk. 2 ♂, 8 ♀. 4420.
Nomada trapidoi Michener. 2 ♂, 1 ♀. 5288.
Odyneropsis gertschi Michener. 3 ♀. 5289.
Osmia brevior Michener. 3 ♀. 4395.
Osmia claremontensis Michener. 1 ♂. 4407.
Osmia dakotensis Michener. 1 ♀. 4405.
Osmia francisconis White. 2 ♀. 4492.
Osmia lawae Michener. 1 ♂, 2 ♀. 4372.
Osmia parallela Michener. 1 ♂, 2 ♀. 4408.
Osmia pingreeana Michener. 1 ♀. 5280.
Osmia potentillae Michener. 1 ♀. 4409.
Osmia ribifloris biedermannii Michener. 8 ♂, 3 ♀. 4404.
Osmia sequoiae Michener. 1 ♀. 4406.
Osmia subpurpurea jamesi Michener. 3 ♀. 4411.
Oreopasites vanduzeei vernalis Linsley. 1 ♂. 4270.
Panurginus atramontensis Crawford. 1 ♂. 4292.
Panurginus gracilis Michener. 1 ♀. 4294.
Panurginus nigrihirtus Michener. 1 ♂, 1 ♀. 4295.
Perdita acapulcona Timberlake. 1 ♂. 5228.
Perdita ainsliei Crawford. 1 ♀. 4300.
Perdita azteca Timberlake. 1 ♂. 5229.
Perdita coahuilensis Timberlake. 4 ♂, 3 ♀. 5381.
Perdita diversa Timberlake. 1 ♂, 3 ♀. 5382.
Perdita euphorbiae Timberlake. 6 ♂, 7 ♀. 5233.
Perdita giliae Timberlake. 2 ♂, 2 ♀. 5235.
Perdita mellea Timberlake. 4 ♂, 7 ♀. 5225.
Perdita miricornis Cockerell. 1 ♂, 1 ♀. 4303.
Perdita mitchelli Timberlake. 2 ♀. 4304.
Perdita obsuripennis Timberlake. 1 ♂, 5 ♀. 5228.
Perdita portalis Timberlake. 1 ♀. 5239.
Perdita ruficauda ornata Timberlake. 5 ♂. 5240.
Perdita salicis occidentalis Timberlake. 2 ♂, 2 ♀. 4306.
Perdita signata Timberlake. 5 ♂, 7 ♀. 5380.
Perdita tristella Timberlake. 1 ♀. 5244.
Perdita turgiceps Timberlake. 26 ♂, 10 ♀. 5245.
Proteriades basingeri Timberlake and Michener. 1 ♂. 4375.
Proteriades boharti Timberlake and Michener. 1 ♂. 4376.
Proteriades cryptanthae Timberlake and Michener. 1 ♂, 2 ♀. 4379.
Proteriades deserticola Timberlake and Michener. 4 ♂, 7 ♀. 4380.
Proteriades incanescens nevadensis Timberlake and Michener. 1 ♀. 4383.

Proteriades nanula Timberlake and Michener. 2 ♂, 2 ♀. 4381.

Proteriades nigrella Michener. 2 ♀. 5276.

Proteriades pygmaea Timberlake and Michener. 2 ♂, 3 ♀. 4384.

Proteriades reducta Timberlake and Michener. 1 ♂, 1 ♀. 4385.

Proteriades seminigra Timberlake and Michener. 1 ♀. 4387.

Proteriades seminigra yosemitensis Timberlake and Michener. 1 ♂, 1 ♀. 4388.

Proteriades tristis Michener. 1 ♀. 4389.

Pseudopanurgus gerardiae Crawford. 1 ♂, 1 ♀. 4296.

Pseudopanurginus nebrascensis timberlakei Michener. 1 ♀. 4297.

Sphecodes macswaini Michener. 2 ♀. 5266.

Stelis anthracina Timberlake. 1 ♂. 5268.

Stelis arizonensis Swenk. 5 ♂. 4299.

Stelis ashmeadiellae Timberlake. 1 ♀. 4311.

Stelis depressa Timberlake. 3 ♂, 1 ♀. 4313.

Stelis hemirhoda Linsley. 2 ♀. 4316.

Stelis micheneri Linsley. 2 ♂. 4318.

Tetralonia lata lautipes Cockerell. 1 ♀. 4437.

Townsendiella californica Michener. 6 ♀. 4422.

Triepeolus rufithorax Graenicher. 1 ♀. 4429.

Trigona katangensis Cockerell. 1 ♀. 4457.

Trigona leucogastra chiriquiensis Schwarz. 1 ♀. 4433.

Trigona mexicana subobscuripennis Schwarz. 2 ♀. 4302.

Trigona pectoralis barrocoloradensis Schwarz. 2 ♀. 4312.

Trophocleptria nigra Michener. 2 ♂, 1 ♀. 5292.

Trophocleptria odontothorax Michener. 2 ♂. 5290.

Xylocopa varians rufotegularis Michener. 1 ♀. 5308.

BRACONIDAE

Agathis wyomingensis Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 284. ♀ holotype. 902.

Aphaereta delosa Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 284. ♂ cotype destroyed, ♀ cotype missing abdomen, 1 ♀ paratype. 885.

Aphaereta subtricarina Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 283. ♀ holotype, 1 ♀ paratype. 886.

Ascogaster mimeticus Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 277. ♀ holotype. 901.

Aspilota columbiana Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 282. ♀ holotype. 887.

Atanycolus calophrys Shenefelt, 1943, Washington State Coll. Res. Studies, vol. 11, p. 72. ♀ holotype. 3520.

Biosteres indotatus Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19. p. 273. ♂ holotype. 861.

Brachistes nocturnus Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 279. ♂ holotype. 895.

Bracon kansensis Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 268. ♀ holotype. 877.

Bracon piceiceps Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 268. ♂ holotype (abdomen missing). 878.

Cardiochiles nigroclypeus Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 275. ♂ holotype, 2 ♂ paratypes. 858.

Chelonus altitudinis Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 278. ♀ holotype. 896.

Chelonus egregicolor Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 278. ♂ holotype. 897.

Chelonus exogyrus Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 287. ♀ holotype. 898.

Chelonus nucleolus Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 287. ♀ holotype. 899.

Chelonus texanoides Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 286. ♀ holotype. 900.

Coenocoelius politifrons Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 279. ♂ holotype. 894.

Crassomicrodus nigricaudus Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 288. ♂ holotype, 1 ♂ paratype. 903.

Diachasma appalachicola Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 272. ♀ holotype. 862.

Diachasma secunda Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 273. ♀ holotype. 863.

Dinotrema signifrons Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 177. ♂ holotype. 888.

Doryctes apacheus Viereck, 1907, Trans. Amer. Ent. Soc., vol. 33, p. 383. ♂ holotype. 884.

Doryctes femur-rubrum Viereck, 1907, Trans. Amer. Ent. Soc., vol. 33, p. 384. ♀ holotype. 883.

Doryctomorpha shoshonea Viereck, 1907, Trans. Amer. Ent. Soc., vol. 33, p. 382. ♀ holotype. 2111.

Hedysomus wichitus Viereck, 1907, Trans. Amer. Ent. Soc., vol. 33, p. 404. ♂ holotype. 907.

Hormiopterus claripennis Brues, 1907, Bull. Wisconsin Nat. Hist. Soc., vol. 5, p. 60. ♀ holotype. 879.

Iphiaulax cinnabarinus Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 286. ♀ holotype. 869.

Iphiaulax melanogaster Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 270. ♀ holotype. 870.

Iphiaulax militaris Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 269. ♀ holotype. 871.

Iphiaulax perepicus Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 285. ♀ holotype. 872.

Iphiaulax propinquus Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 286. ♀ holotype missing abdomen. 873.

Iphiaulax triangulifera Viereck, 1907, Trans. Amer. Ent. Soc., vol. 33, p. 384. ♀ holotype. 868.

Ischneutidea (!) *proteroptoides* Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 274. ♀ holotype missing abdomen. 860.

Lysiphlebus succineus Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 282. ♂ holotype, 1 ♂ paratype. 889.

Lytopylus asygos Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 267. ♀ holotype. 904.

Melanobracon ulmicola Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 176. ♂ and ♀ cotypes, 2 ♀ paratypes. 876.

Meteorus campestris Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 281. ♀ holotype. 890.

Meteorus noctivagus Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 281. ♀ holotype. 891.

Meteorus relativus Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 280. ♂ holotype. 892.

Microdus agathoides Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 277. ♀ holotype—lost. 905.

Microdus castaneicinctus Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 276. ♀ holotype. 906.

Microdus nigrotrochantericus Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 275. ♀ holotype. 910.

Microdus pimploides Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 276. ♂ holotype. 909.

Microdus wichitaensis Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 276. ♀ holotype missing head, abdomen and wings. 911.

Microgaster tuckeri Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 274. ♀ holotype. 859.

Opius aberrans Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 271. ♀ holotype, 1 ♀ paratype. 864.

Opius basiniger Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 270. ♀ holotype missing abdomen. 865.

Opius luteiceps Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 271. ♂ holotype. 866.

Opius nigrocastaneus Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 272. ♂ holotype. 867.

Phaenodus caddous Viereck, 1907, Trans. Amer. Ent. Soc., vol. 33, p. 403. ♀ holotype. 908.

Rhogas melanothorax Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 267. ♀ holotype missing head. 882.

Vipio erythrus Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 284. ♂ holotype, 1 ♂ paratype. 874.

Vipio piceipectus Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 269. ♀ holotype. 875.

Zele crassicalcaratus Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 279. ♂ holotype—lost. 893.

BRACONIDAE—Paratypes

Atanycolus crassicruris Shenefelt. 2 ♀. 3521.
Atanycolus impressifrons Shenefelt. 1 ♀. 3524.
Atanycolus longifemoralis Shenefelt. 1 ♀. 3522.
Atanycolus malii Shenefelt. 1 ♀. 3525.
Bracon charus Riley. 3 ♂. 3523.
Bracon pascuensis Shenefelt. 2 ♀, 1 ♂. 2776.
Heterospilus beameri Rohwer. 5 ♀, 9 ♂. 880.

CHALCIDOIDEA

Leucospis bicincta Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 227. ♂ holotype. 913.

CHALCIDOIDEA—Paratypes

Necremnus breviramulus Gahan. 15 ♀, 3 ♂. 3282.
Orasema beameri Gahan. 8 ♀, 3 ♂. 3280.
Orasema cockerelli Gahan. 2 ♀. 3281.
Spilochalcis clora Burks. 1 ♂. 3059.
Spilochalcis dema Burks. 1 ♀. 3060.

CHRYSIDIDAE

Chrysis equidens Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 193. ♀ holotype, 1 ♀ paratype. 915.

Chrysis kahli Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 194. ♀ holotype. 916.

Chrysis kansensis Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 193. ♀ holotype. 917.

Chrysis pattonella Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 194. ♀ holotype. 918.

Chrysis snowi Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 195. ♀ holotype. 919.

Notozus connexus Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 192. ♀ holotype. 914.

CYNIPOIDEA

Aspicera africana Kinsey, 1919, Psyche, vol. 26, p. 162. 1 ♂ and 1 ♀ cotype. 807.

CYNIPOIDEA—Paratypes

Acraspis undulata Gillette. 1 ♀. 3451.
Andricus biconicus Weld. 4 ♀. 3452.
Andricus foliosus Weld. 2 ♀. 3453.
Andricus robustus Weld. 2 ♀. 3454.
Callirhytis fructuosa Weld. 4 ♀. 3455.
Compsodryoxenus illinoisensis Weld. 1 ♀. 3456.
Disholcaspis terrestris Weld. 2 ♀. 4438.
Holcaspis monticola Gillette. 1 ♀. 3458.
Neuroterus verna Gillette. 2 ♀. 3459.
Rhodites arefactus Gillette. 2 ♀. 3457.

EVANIIDAE

Hyptia texana Bradley, 1908, Trans. Amer. Ent. Soc., vol. 34, p. 161. ♀ holotype. 788.

FORMICIDAE—Paratypes

Lasius crypticus Wilson. 1 ♂, 1 worker. 5398.
Lasius sitiens Wilson. 1 worker. 5399.
Lasius fallax Wilson. 3 workers. 5400.

GASTERUPTIIDAE

Tropaulacus torridus Bradley, 1908, Trans. Amer. Ent. Soc., vol. 34, p. 125. ♀ holotype. 3811.

GASTERUPTIIDAE—Paratypes

Gasteruption amputatum Townes. 1 ♂. 3814.
Rhydinofoenus floridanus bradleyi Townes. 1 ♀. 3815.
Rhydinofoenus striatus Townes. 2 ♂. 3813.
Rhydinofoenus tarsatoris solaris Townes. 1 ♀. 3812.

ICHNEUMONIDAE

Agathobancus bradleyi Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 303. ♀ holotype. 843.

Amorphota angusta Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 180. ♀ holotype. 820.

Amorphota confluens Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 217. ♀ holotype. 821.

Amorphota ferruginosa Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 220. ♀ holotype. 822.

Amorphota galvestonensis Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 219. ♀ holotype. 828.

Amorphota nocturna Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 308. ♂ holotype. 827.

Amorphota paenexareolata Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 309. ♂ holotype. 829.

Amorphota perrivalis Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 307. 1 ♂ and 1 ♀ cotypes, 1 ♂ paratype. 830.

Amorphota relativa Viereck, 1902, Canad. Ent., vol. 34, p. 67. ♀ holotype. 831.

Angitia autumnalis Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 181. ♀ holotype (abdomen missing). 833.

Anomalon paeneferrugineum Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 310. ♀ holotype. 803.

Anomalon fulvescens var. *hemimelas* Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 218. ♀ holotype. 826.

Aranetia leucotaenia Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 318. ♀ holotype. 808.

Atrometus angitioides Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 311. ♀ holotype. 804.

Boethus aenigmaticus Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 314. ♂ holotype. 796.

Callidiotes kansensis Brues, 1907, Wisconsin Nat. Hist. Soc. Bull., vol. 5, p. 55. ♀ holotype. 798.

Campoplex photomorphus Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 309. ♀ holotype. 805.

Campoplex wyomingensis Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 242. ♂ holotype. 806.

Cryptus citrinimaculatus Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 320. ♂ holotype. 810.

Cryptus consobrinus Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 225. ♀ holotype. 811.

Cryptus crassisculptus Pratt, 1945, Amer. Midland Nat., vol. 34, p. 573. ♀ holotype. 2407.

Cryptus politicalypterus Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 293. ♂ holotype. 812.

Erymotylus felti Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 312. ♀ holotype. 823.

Exetastes infumatricus Cushman, 1937, Proc. U. S. Nat. Mus., vol. 84, p. 283. ♀ holotype. 2409.

Exetastes infumatricus Cushman, 1937, Proc. U. S. Nat. Mus., vol. 84, p. 288. ♀ holotype. 2387.

Glypta aprilis Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 316. ♀ holotype. 853.

Glypta brunneisigna Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 316. ♀ holotype. 854.

Glypta egregiafovea Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 292. ♀ holotype. 852.

Glypta succineipennis Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 315. ♀ holotype. 851.

Harrimaniella paeneimitatrix Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 317. ♀ holotype. 809.

Hemiteles cushmani Butcher, 1933, Ann. Ent. Soc. Amer., vol. 26, p. 76. ♀ holotype, ♂ allotype, 3 ♀ and 4 ♂ paratypes. 2406.

Hemiteles cheboyganensis Butcher, 1933, Ann. Ent. Soc. Amer., vol. 26, p. 77. ♀ holotype. 2408.

Hemiteles lathroscopoides Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 294. ♂ holotype. 815.

Hemiteles manitouensis Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 290. ♂ holotype. 816.

Ichneumon arizonensis Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 295. ♀ holotype. 789.

Ichneumon citrinifascialis Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 297. ♂ holotype. 790.

Ichneumon egregiafacialis Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 291. ♂ holotype. 824.

Ichneumon flavofascialis Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 291. ♂ holotype. 791.

Ichneumon hemimelanarius Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 226. ♂ holotype. 792.

Ichneumon humphreyi Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 296. ♂ holotype. 793.

Ichneumon nigrosignatus Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 297. ♂ holotype. 794.

Ichneumon oryxicornis Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 324. ♂ holotype. 856.

Idecthis biconjunctus Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 180. ♂ holotype. 835.

Idecthis paenerivalis Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 217. 1 ♀ and 1 ♂ cotypes. 836.

Ischnoscopus taeniatus Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 305. ♀ holotype. 832.

Limnerium lawrencei Vierick, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 178. ♀ holotype. 837.

Limnerium perdistinctum Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 304. ♀ holotype, 2 ♀ paratypes. 838.

Limnerium vigilis Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 179. ♂ holotype. 839.

Mesochorus noctivagus Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 303. ♀ holotype. 842.

Mesostenus discoidaloides Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 319. ♀ holotype. 813.

Metopius grandior Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 314. ♀ holotype. 795.

Nematopodius exclamans Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 318. ♀ holotype. 3467.

Netelia cushmani Townes, 1939, Lloydia, vol. 1, p. 206. ♂ holotype. 3409.

Netelia glabra Townes, 1939, Lloydia, vol. 1, p. 183. ♂ holotype. 3412.

Olesicampa melanerythrogastra Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 306. 1 ♀ and 1 ♂ cotypes. 834.

Ophion idoneum Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 312. ♂ holotype. 800.

Pezomachus alogus Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 321. ♂ holotype. 817.

Pezomachus homalommoides Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 294. ♂ holotype. 818.

Pezomachus testaceicoxus Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 322. ♂ holotype. 819.

Phygadeuon spinicoxus Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 289. ♀ holotype. 857.

Pimpla landerensis Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 243. ♀ holotype. 849.

Pimpla parvialba Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 182. ♀ holotype. 850.

Platylabus omniferrugineus Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 322. ♀ holotype. 855.

Pristomerus appalachianus Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 298. 1 ♀ (abdomen missing) and 1 ♂ (abdomen missing) cotypes. 840.

Pristomerus appalachianus var. *dorsocastaneus* Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 299. 1 ♀ and 1 ♂ cotypes. 841.

Scopiorus monticola Brues, 1907, Wisconsin Nat. Hist. Bull., vol. 5, p. 56. ♀ holotype. 799.

Sychnoporthus tuckeri Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 315. ♀ holotype. 814.

Syndipius erythrogaster Viereck, 1908, Trans. Amer. Ent. Soc., vol. 33, p. 385. ♂ holotype (missing abdomen). 797.

Thersilochus egregiacolor Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 302. ♀ holotype, 1 ♀ paratype. 844.

Thersilochus hamiltonensis Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 301. ♂ holotype. 845.

Thersilochus mimeticus Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 300. ♀ holotype. 846.

Thersilochus quintilis Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 301. ♂ holotype. 847.

Thersilochus snowi Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 299. ♀ holotype. 848.

Thyreodon morio race *transitionalis* Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 225. ♀ holotype. 801.

Thyreodon snowi Viereck, 1905, Trans. Kansas Acad. Sci., vol. 19, p. 313. ♀ holotype (tip of abdomen damaged), 1 ♀ paratype. 802.

ICHNEUMONIDAE—Paratypes.

Conocalama occidentalis var. *luteata* Hopper. 1 ♀. 2427.
Cryptus associatus Pratt. 1 ♀. 3299.
Cryptus asymmetricus Pratt. 1 ♀, 1 ♂. 3297.
Cryptus flagellatus Pratt. 2 ♀. 3300.
Cryptus mutatus Pratt. 1 ♀. 3298.
Cryptus temporalis Pratt. 1 ♂. 3296.
Echthronomas ochreofrons lexiphaga Walley. 1 ♂. 4222.
Erromenus dolichops Townes and Townes. 1 ♂. 3605.
Erromenus nasalis Townes and Townes. 1 ♂. 3604.
Exetastes angustoralis Cushman. 1 ♀, 1 ♂. 2388.
Exetastes bituminosus Cushman. 1 ♀. 2386.
Exetastes geminus Cushman. 1 ♀, 1 ♂. 2385.
Hoplismenus teres Swift. 1 ♂. 4221.
Megarhyssa icterosticta Michener. 5 ♀, 2 ♂. 2579.
Netelia acuminata Townes. 1 ♀. 3407.
Netelia magniceps Townes. 1 ♀. 3413.
Netelia pallens occidentalis Townes. 1 ♂. 3408.

Netelia recta Townes. 1 ♂. 3410.

Netelia ovalis Townes. 1 ♀. 3468.

Symboethus communis foraminatus Townes and Townes. 1 ♀, 1 ♂. 3606.

Symboethus viator Townes and Townes. 1 ♀, 1 ♂. 3603.

MUTILLIDAE

Dasymutilla arcana Mickel, 1928, Bull. U. S. Nat. Mus., vol. 143, p. 217. ♂ holotype, 3 ♂ paratypes. 1059.

Dasymutilla beameri Mickel, 1936, Ann. Ent. Soc. Amer., vol. 29, p. 48. ♀ holotype. 2112.

Dasymutilla campanula Mickel, 1928, Bull. U. S. Nat. Mus., vol. 143, p. 227. ♀ holotype. 934.

Dasymutilla candida Mickel, 1928, Bull. U. S. Nat. Mus., vol. 143, p. 296. ♂ holotype. 1038.

Dasymutilla curticeps Mickel, 1928, Bull. U. S. Nat. Mus., vol. 143, p. 173. ♀ holotype. 2116.

Dasymutilla dionysia Mickel, 1928, Bull. U. S. Nat. Mus., vol. 143, p. 104. ♀ holotype. 923.

Dasymutilla eminentia Mickel, 1928, Bull. U. S. Nat. Mus., vol. 143, p. 79. ♂ holotype, 9 ♂ paratypes. 929.

Dasymutilla errabunda Mickel, 1928, Bull. U. S. Nat. Mus., vol. 143, p. 269. ♂ holotype. 1063.

Dasymutilla fulgida Mickel, 1928, Bull. U. S. Nat. Mus., vol. 143, p. 76. ♀ holotype, 3 ♀ paratypes. 2122.

Dasymutilla furina Mickel, 1928, Bull. U. S. Nat. Mus., vol. 143, p. 82. ♀ holotype, ♂ allotype. 2121.

Dasymutilla meracula Mickel, 1928, Bull. U. S. Nat. Mus., vol. 143, p. 201. ♂ holotype, 2 ♂ paratypes. 931.

Dasymutilla myrice Mickel, 1928, Bull. U. S. Nat. Mus., vol. 143, p. 121. ♂ holotype, 28 ♂ paratypes. 1060.

Dasymutilla nupera Mickel, 1928, Bull. U. S. Nat. Mus., vol. 143, p. 103. ♀ holotype. 924.

Dasymutilla saetigera Mickel, 1928, Bull. U. S. Nat. Mus., vol. 143, p. 211. ♀ holotype. 930.

Dasymutilla satanas Mickel, 1928, Bull. U. S. Nat. Mus., vol. 143, p. 239. ♀ holotype, 3 ♀ paratypes. 1070.

Mutilla apachea Viereck, 1908, Trans. Amer. Ent. Soc., vol. 33, p. 386. ♂ holotype. 1065.

Mutilla crepuscula Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 188. ♂ holotype. 1039.

Mutilla imperialiformis Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 189. ♂ holotype. 1041.

Mutilla montivagoides Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 185. ♀ holotype. 1042.

Mutilla nigricauda Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 187. ♀ holotype. 1056.

Mutilla phoenix Fox, 1899, Trans. Amer. Ent. Soc., vol. 25, p. 247. ♂ lectoallotype (designated by Mickel, 1928, Bull. U. S. Nat. Mus., vol. 143, p. 87). 926.

Mutilla prognoides Viereck 1906, Trans. Amer. Ent. Soc., vol. 32, p. 186. ♀ holotype. 1057.

Mutilla quintilis Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 187. ♂ holotype. 1040.

Pseudomethoca carbonaria Mickel, 1924, Proc. U. S. Nat. Mus., vol. 64, p. 43. ♂ holotype. 1049.

MUTILLIDAE—Paratypes

Dasymutilla atrifulva Mickel. 3 ♂. 1036.
Dasymutilla calorata Mickel. 1 ♀. 1071.
Dasymutilla dilucida Mickel. 1 ♀. 1064.
Dasymutilla helva Mickel. 3 ♀. 1066.
Dasymutilla hirticula Mickel. 1 ♂. 1054.
Dasymutilla hora Mickel. 1 ♂. 935.
Dasymutilla intermixta Mickel. 2 ♂. 1068.
Dasymutilla magnifica Mickel. 2 ♀, 1 ♂. 1069.
Dasymutilla nitidula Mickel. 2 ♀. 932.
Dasymutilla nogalensis Mickel. 11 ♀. 1067.
Dasymutilla ocydrome Mickel. 2 ♂. 1037.
Dasymutilla reclusa Mickel. 6 ♂. 1058.
Dasymutilla reperticia Mickel. 1 ♂. 1061.
Dasymutilla rubricosa Mickel. 1 ♂. 936.
Dasymutilla sophrona Mickel. 1 ♂. 1062.
Dasymutilla stevensi Mickel. 2 ♀. 925.
Pseudomethoca paludata Mickel. 2 ♀. 1053.

PAMPHILIIDAE

Neurotoma crataegi Middlekauff. 2 ♂ paratypes. 3309.

PERGIDAE

Hylotoma spiculata McGillivray. 1 ♀ paratype. 785.

POMPILIDAE

Anoplius snowi Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 202. ♂ holotype. 940.

Aporinellus taeniatus baboquivari Evans, 1951, Trans. Amer. Ent. Soc., vol. 77, p. 286. ♀ holotype. 4516.

Aporus ferrugineipes Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 203. ♂ holotype. 937.

Cryptocheilus paeneparcus Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 202. ♀ holotype. 941.

Pepsis angustimarginata Viereck, 1907, Trans. Amer. Ent. Soc., vol. 33, p. 398. ♀ holotype. 939.

Pompilinus splendens Dreisbach, 1949, Ent. Amer. (n. s.), vol. 29, p. 20. ♂ holotype. 4522.

POMPILIDAE—Paratypes

Anoplius krombeini Evans. 1 ♀, 1 ♂. 4519.
Aporinellus bridwelli Evans. 1 ♂. 4515.
Aporinellus sinuatus Evans. 3 ♀, 5 ♂. 4517.
Episyron quinquenotatus Evans. 1 ♀, 1 ♂. 4518.
Pepsis bequaerti Salman. 1 ♂. 938.
Pompilinus pseudoreductus Dreisbach. 1 ♂. 4526.
Pompilinus rectangularis Dreisbach. 1 ♂. 4525.
Pompilus parvulus otomi Evans. 1 ♀, 2 ♂. 4645.
Pompilus solonus silvivagus Evans. 1 ♀. 4520.

SCELIONIDAE

Scelio monticola Brues, 1906, *in* Viereck, Trans. Amer. Ent. Soc., vol. 32, p. 184. 1 ♀ holotype. 920.

Scelio striaticollis Brues, 1906, *in* Viereck, Trans. Amer. Ent. Soc., vol. 32, p. 222. ♀ holotype. 921.

Scelio venata Brues, 1906, *in* Viereck, Trans. Amer. Ent. Soc., vol. 32, p. 228. ♀ holotype (abdomen missing). 922.

SPHECIDAE

Ancistromma paenerugosa Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 210. ♂ holotype. 942.

Ancistromma tachysphecoides Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 209. ♂ holotype. 947.

Ancistromma vegetoides Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 208. ♀ holotype. 825.

Ancistromma zerbei Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 208. ♀ holotype. 946.

Bembix arcuata Parker, 1917, Proc. U. S. Nat. Mus., vol. 52, p. 81. ♀ allotype. 963.

Bembix heliathopolis Parker, 1917, Proc. U. S. Nat. Mus., vol. 52, p. 113. ♀ holotype, ♂ allotype, 3 ♂ paratypes. 960.

Bembix latifrons Parker, 1917, Proc. U. S. Nat. Mus., vol. 52, p. 116. ♀ holotype. 964.

Bicyrtes annulata Parker, 1917, Proc. U. S. Nat. Mus., vol. 52, p. 67. ♀ holotype, 1 ♀ paratype. 965.

Bicyrtes gracilis Parker, 1917, Proc. U. S. Nat. Mus., vol. 52, p. 68. ♂ holotype. 966.

Crabro canonicola Viereck, 1908, Trans. Amer. Ent. Soc., vol. 33, p. 403. ♀ holotype, 1 ♀ paratype. 974.

Crabro cinctibellus Viereck, 1908, Trans. Amer. Ent. Soc., vol. 33, p. 401. 1 ♀ and 1 ♂ cotypes, 1 ♀ and 2 ♂ paratypes. 975.

Crabro clarconis Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 213. ♀ holotype. 976.

Crabro papagorum Viereck, 1908, Trans. Amer. Ent. Soc., vol. 33, p. 401. ♀ holotype. 977.

Crabro viciniformis Viereck, 1907, Trans. Amer. Ent. Soc., vol. 33, p. 381. ♀ holotype. 978.

Didineis crassicornis Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 204. ♂ holotype. 1008.

Diodontus brunneicornis Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 212. ♂ holotype. 5450.

Eucerceris lacunosa Scullen, 1939, Oregon State Monogr., Studies in Ent., vol. 1, p. 19. ♂ holotype. 4210.

Gorytes gulielmi Viereck, 1907, Trans. Amer. Ent. Soc., vol. 33, p. 408. ♀ holotype. 1003.

Gorytes papagorum Viereck, 1907, Trans. Amer. Ent. Soc., vol. 33, p. 400. 1 ♀ and 1 ♂ cotypes, 3 ♀ and 1 ♂ paratypes. 1005.

Harpactus gyponae Williams, 1913, Univ. Kansas Sci. Bull., vol. 8, p. 223. ♀ holotype. 1004.

Larropsis ater Williams, 1913, Univ. Kansas Sci. Bull., vol. 8, p. 146. ♂ holotype. 945.

Larropsis minor Williams, 1913, Univ. Kansas Sci. Bull., vol. 8, p. 146. ♂ holotype (abdomen missing). 2113.

Niteliopsis foxii Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 207. ♀ holotype. 961.

Niteliopsis kansensis Williams, 1913, Univ. Kansas Sci. Bull., vol. 8, p. 178. ♀ holotype. 962.

Nysson clarconis Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 204. ♂ holotype. 1006.

Nysson intermedius Viereck, 1907, Trans. Amer. Ent. Soc., vol. 33, p. 409. ♀ holotype. 1007.

Oxybelus exclamans Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 215. ♀ holotype (missing from collection, but probably loaned to some specialist). 1048.

Passaloecus equalis Viereck , 1906, Trans. Amer. Ent. Soc., vol. 32, p. 212. ♀ holotype. 971.

Philanthus clarconis Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 206. ♀ holotype. 1009.

Philanthus magdalenae Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 240. ♀ holotype. 1010.

Plenoculus apicalis Williams, 1914, Univ. Kansas Sci. Bull., vol. 8, p. 175. ♀ holotype. 959.

Podalonia puncta Murray, 1940, Ent. Americana (n. s.), vol. 20, p. 36. ♀ allotype, 4 ♀ and 1 ♂ paratypes. 5246.

Stictia spinifera Mickel, 1916, Trans. Amer. Ent. Soc., vol. 42, p. 418. ♂ holotype, 1 ♂ paratype. 970.

Stictiella divergens Parker, 1917, Proc. U. S. Nat. Mus., vol. 52, p. 55. ♂ holotype, 1 ♂ paratype. 969.

Stictiella melampous Parker, 1917, Proc. U. S. Nat. Mus., vol. 52, p. 43. ♂ holotype, 1 ♂ paratype. 970.

Tachysphex clarconis Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 211. ♀ holotype. 948.

Tachysphex consimiloides Williams, 1913, Univ. Kansas Sci. Bull., vol. 8, p. 164. ♀ holotype. 949.

Tachysphex crassiformis Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 210. ♀ holotype. 950.

Tachysphex crenuloides Williams, 1913, Univ. Kansas Sci. Bull., vol. 8, p. 168. ♀ holotype. 951.

Tachysphex dentatus Williams, 1913, Univ. Kansas Sci. Bull., vol. 8, p. 169. ♀ holotype. 952.

Tachysphex glabrior Williams, 1913, Univ. Kansas Sci. Bull., vol. 8, p. 171. ♂ holotype. 953.

Tachysphex intermedius Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 211. ♂ holotype. 944.

Tachysphex nigrocaudatus Williams, 1913, Univ. Kansas Sci. Bull., vol. 8, p. 167. ♀ holotype. 954.

Tachysphex plenoculiformis Williams, 1913, Univ. Kansas Sci. Bull., vol. 8, p. 167. ♀ holotype. 955.

Tachysphex robustior Williams, 1913, Univ Kansas Sci. Bull., vol. 8, p. 164. ♂ holotype. 956.

Tachysphex sculptiloides Williams, 1913, Univ. Kansas Sci. Bull., vol. 8, p. 166. ♀ holotype. 957.

Tachysphex sepulchralis Williams, 1913, Univ. Kansas Sci. Bull., vol. 8, p. 169. ♀ holotype. 958.

Trypoxylon quintilis Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 206. ♂ holotype. 972.

Trypoxylon regularis Viereck, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 205. ♂ holotype (abdomen missing). 973.

SPHECIDAE—Paratypes

Bembecinus bishoppi Krombein and Willink. 1 ♀. 4193.
Bembecinus wheeleri Krombein and Willink. 1 ♀. 4194.
Ectemnius scaber rufescens Krombein. 1 ♀, 1 ♂. 5138.
Eucerceris arenaria Scullen, 3 ♀, 7 ♂. 4209.
Microbembex aurata Parker. 2 ♀, 1 ♂. 967.
Philanthus tarsatus Smith. 1 ♀. 2115.
Podalonia clypeata Murray. 4 ♀. 2114.
Podalonia melaena Murray. 1 ♂. 1051.
Podalonia mickeli Murray. 4 ♀, 1 ♂. 1052.
Podalonia parallela Murray. 1 ♂. 1050.
Podalonia occidentalis Murray. 3 ♀. 1055.
Podalonia pubescens Murray. 3 ♀, 5 ♂. 3411.
Podalonia sericea Murray. 11 ♀, 12 ♂. 4436.
Sphex ferrugineus Fox. 2 ♂ (used for first ♂ description by Fernald, 1906, Proc. U. S. Nat. Mus., vol. 31, p. 331). 943.
Stictiella callista Parker, 1 ♀. 968.
Trypoxylon sculleni Sandhouse. 1 ♂. 2502.

TENTHREDINIDAE

Dolerus illini Ross. 1 ♀, 3 ♂ paratypes. 786.
Dolerus simulans Rohwer. 1 ♂ paratype. 787.

TIPHIIDAE

Aglyptacros sulcatus Mickel and Krombein, 1942, Amer. Mid. Nat., vol. 28, p. 674. ♀ holotype. 3366.

Astigmometopa emarginata Mickel and Krombein, 1942, Amer. Mid. Nat., vol. 28, p. 668. ♀ holotype. 3367.

TIPHIIDAE—Paratypes

Brachycistis stictinotus Viereck. 1 ♂. 5449.
Myrmosa nocturna Krombein. 4 ♂. 2603.
Myrmosa nocturna rufigastra Krombein. 2 ♂. 2604.

VESPIDAE

Eumenes bolliformis Viereck, 1908, Trans. Amer. Ent. Soc., vol. 33, p. 387. 1 ♀ and 1 ♂ cotypes, 1 ♀ paratype. 1043.

Eumenes cruciferorum Viereck, 1908, Trans. Amer. Ent. Soc., vol. 33, p. 388. 1 ♀ and 1 ♂ cotypes. 1044.

Eumenes enigmatus Viereck, 1908, Trans. Amer. Ent. Soc., vol. 33, p. 389. ♂ holotype, 1 ♂ paratype. 1045.

Eumenes globulosiformis Viereck, 1908, Trans. Amer. Ent. Soc., vol. 33, p. 386. 1 ♀ and 1 ♂ cotypes. 1046.

Eumenes marginilineatus Viereck, 1907, Trans. Amer. Ent. Soc., vol. 33, p. 381. ♂ holotype. 1047.

Odynerus anormiformis Viereck, 1908, Trans. Amer. Ent. Soc., vol. 33, p. 407. ♀ holotype. 980.

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Odynerus tempiferus Viereck, 1908, Trans. Amer. Ent. Soc., vol. 33, p. 392. ♂ holotype. 1001.

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A Revision of the Bees of the Genus Melissodes in North and Central America. Part II (Hymenoptera, Apidae)*

BY

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ABSTRACT: This is the second part of a monographic revision of the bee genus *Melissodes* in North and Central America. Ten species belonging to four subgenera are described. Ten names are relegated to synonymy. One new species, *M. mitchelli*, is described.

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INTRODUCTION

This is the second part of a revision of the bees of the genus *Melissodes* in North and Central America. Ten species belonging to four subgenera are treated. A total of 2,088 specimens representing these ten species have been examined.

Explanations of the methods used in describing the species, the meanings of certain descriptive terminology and methods used in taking certain measurements are described in a section on descriptive methodology in the first part of this revision (LaBerge, 1956). The reader is also referred to the first part of this revision for a complete list of acknowledgments. Certain persons have been of invaluable aid in comparing specimens sent to them with type specimens in their care, in lending types and in generously giving of their time and advice. I am grateful to Dr. I. H. H. Yarrow of the British Museum (Natural History) for generously giving of his time to make comparisons with types in his care and for information concerning those types. Mr. K. V. Krombein of the U. S. National Museum is especially thanked for answering questions concerning types in his care and for facilitating the loan of certain specimens including paratypes and cotypes. Professor P. H. Timberlake of the Citrus Experiment Station, Riverside, California, Dr. E. S. Ross of the California Academy of Sciences, San Francisco, California, Dr. Hugo G. Rodeck of the University of Colorado, Boulder, Colorado, and Dr. T. B. Mitchell of North Carolina State College, Raleigh, North Carolina, are thanked for the generous loan of type specimens in their care. I am grateful to Dr. C. D. Michener of the University of Kansas, Lawrence, Kansas, for his continued interest and guidance without which this study would have been much more difficult. Much of the research involved in this work was done while holding a National Science Foundation Fellowship at the University of Kansas during the academic years of 1952-1954 and the author is grateful for this aid.

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Subgenus *Tachymelissodes* LaBerge

Tachymelissodes LaBerge, 1956, Univ. Kansas Sci. Bull., vol. 37, p. 1170.

Type species. Melissodes dagosa Cockerell, 1909, by original designation.

This subgenus includes three species of *Melissodes* which have the distal pubescent bands of the metasoma narrow, situated on the apices of terga 2 to 4, subequal in width to each other and of about equal width across each tergum in both sexes. In addition, the males have short antennae which barely reach or do not reach the first metasomal tergum in repose and have the minimum length of the first flagellar segment equal to half or more of the maximum length of the second segment.

KEY TO THE SPECIES OF THE SUBGENUS TACHYMELISSODES

Males

1. Apical portion of pygidial plate half or less as broad as basal portion of plate; labrum black; mandible with large basal yellow spot; clypeus all or partly black .... *sphaeralceae*

Apical portion of pygidial plate broader than half basal width of plate; labrum often with median yellow spot; mandible usually with basal yellow spot; clypeus usually yellow except dark spots at tentorial pits........ 2

2(3). Basal areas of terga 1 to 3 with ground spaces dulled by dense transverse shagreening; labrum without yellow spot; clypeus with small regular punctures separated by less than one puncture width .... *opuntiella*

Basal areas of terga 1 to 3 with ground spaces shiny, with delicate transverse shagreening which scarcely dulls surface, or unshagreened; labrum usually with small median yellow spot; clypeus with coarse punctures which are irregular in size and spacing, *dagosa*

Females

1. Clypeal punctures small, round, evenly spaced, separated by one puncture width or less (mostly by half a puncture width or less); distal pale band of tergum 2 reaches apex of tergum medially, not interrupted medially; hairs of inner surfaces of hind basitarsi yellow or pale red 2

Clypeal punctures coarse, some elongate, some separated by more than one puncture width at least basally; distal pale band of tergum 2 separated from apex of tergum medially, usually narrowly interrupted medially hairs of inner surfaces of hind basitarsi often dark brown or black, occasionally yellowish red, *dagosa*

2(1). Terga 2 and 3 with interband zone with small shallow punctures and ground areas dulled by dense transverse shagreening; basal half of tergum 1 with small shallow punctures, ground areas dulled by dense shagreening; mesoscutum with no brown hairs, or brown hair patch extends anteriorly to a transverse line at about middle of tegulae .... *opuntiella*

Terga 2 and 3 with interband zone coarsely and irregularly punctate, some punctures 2 or 3 times diameter of others, ground areas shagreened but moderately shiny; basal half of tergum 1 with distinct punctures, ground areas shagreened but moderately shiny; mesoscutum with patch of brown hairs usually extending forward to or beyond a transverse line at anterior margins of tegulae . . . . . . *sphaeralceae*

Melissodes (Tachymelissodes) dagosa Cockerell

Melissodes dagosa Cockerell, 1909, Canad. Ent., vol. 41, p. 128; 1928; Univ. Colorado Studies, vol. 16, p. 114; Bohart, Knowlton and Bailey, 1950, Utah State Agric. Coll., mimeo. ser. no. 371, p. 5.

Melissodes calloleuca Cockerell, 1924, Pan-Pacific Ent., vol. 1, p. 55 (new synonymy).

This is the most common and widespread species of this subgenus The females can be recognized by the coarse clypeal punctation, the usually narrowly interrupted and slightly arched pubescent band of tergum 2 and the hairs of the inner surfaces of the hind basitarsi often being dark brown to black. The males can be recognized by the ground areas of the metasoma and clypeus being shiny, the coarse clypeal punctation and the shape of the pygidial plate as described below.

Female: Measurements and ratios: N, 20; length, 10-12 mm.;

width, 3.5-4.5 mm.; wing length, M = 3.54 ± 0.169 mm.; hooks in hamulus, M = 12.10 ± 0.049; flagellar segment 1/segment 2, M = 2.41 ± 0.028.

Structure and color: Integument black except as follows: apical half of mandible usually red with median golden macula; lower surface of flagellum (except segment 1 and basal half of segment 2) yellow to dark red; eyes blue or greenish blue; tarsi dark reddish brown, claws red basally; tibial spurs pale yellow to pale brown; apices of terga 2-4 (beneath pale pubescent bands) slightly hyaline, brown; apex of tergum 1 usually narrowly hyaline, yellow to brown; sterna often red basally and hyaline apically, except last 2 or 3; wing membranes slightly infumate, veins dark reddish brown to black; tegulae piceous.

Clypeus coarsely and irregularly punctate, punctures, especially basally, often separated by one to two puncture widths, several punctures usually elongate, ground areas shiny, slightly or not at all shagreened; supraclypeal area with deep round punctures widely separated medially, shiny; galeae shiny, unshagreened and sparsely punctate above; maxillary palpal segments in ratio of about 3.0:2.5:2.0:1.5. Mesoscutum with punctures small, round, separated by 2 to 4 puncture widths posteromedially and crowded anteriorly and peripherally, ground shiny; scutellum with punctures similar to those of mesoscutum but separated mostly by about 2 puncture widths, ground shiny; metanotum with small crowded punctures, shiny dorsomedially; lateral surfaces of mesepisterna with deep punctures separated mostly by half of one puncture width or less, ground areas shiny, unshagreened; propodeum with dorsal surface irregularly reticulorugose, dulled by fine tessellation. Metasomal tergum 1 with basal ⅗ or slightly more with indistinct round punctures separated by one puncture width or less, ground areas dulled by fine transverse shagreening, moderately shiny; tergum 2 with interband zone with small, indistinct punctures separated by 1 to 2 puncture widths medially and by 1 puncture width or less laterally, ground areas dulled by dense, fine shagreening, moderately shiny, especially laterally; interband zones of terga 3 and 4 similar to that of tergum 2 but punctures more crowded.

Hair: On head silvery white except as follows: in darkest specimens hairs of clypeus, labrum, mandibles and vertex between apices of compound eyes dark brown, in palest specimens labral hairs ochraceous and with a few short brown hairs on vertex between apices of compound eyes and lateral ocelli. Mesoscutum often with posteromedian patch of dark brown hairs extending forwards to a transverse line at middle of tegulae, occasionally dark mesoscutal hairs absent, usually posteromedial area with few or no hairs; scutellum usually with the sparse median hairs brown; mesepisterna often with hairs of anterior, ventral and lower lateral surfaces dark brown, occasionally all pale; pale hairs of dorsum of thorax white to pale yellow, laterally and on propodeum white. Metasomal tergum 1 with long hairs of basal ⅗ white; tergum 2 with distal and basal pubescent bands silvery white, interband zone with short, brown, subappressed hairs, distal band usually narrowly interrupted medially and separated from apex of tergum in median third or less by narrow zone of short, simple, brown hairs (often rubbed off); tergum 3 and 4 similar to tergum 2 but distal pale bands not interrupted medially nor separated from apices of terga by zones of brown hairs and basal bands consist of dark brown tomentum; terga 5 and 6 with long, appressed, dark brown hairs, white to ochraceous lateral tufts present in pale specimens; sternal hairs dark brown with fringes of long white hairs on apices of all but last two sterna, in darkest specimens apical fringe of hairs pale only laterally. Legs with white hairs except red or yellow on inner surfaces of tarsi and dark brown hairs on basitibial plates in palest specimens; in darkest specimens legs with dark brown hairs except as follows; a few white to ochraceous hairs on outer surfaces of fore and middle tibiae, scopal hairs silvery white except just below basitibial plates and at apices of basitarsi; scopal hairs with relatively few branches (usually 3 to 6 on either side of rachis) and with strong rachises which extend beyond branched portion of hairs by about ⅓ length of latter.

Male: Measurements and ratios: N, 20; length, 8-11 mm.; width, 2.5-3.5 mm.; wing length, M = 3.25 ± 0.258 mm.; hooks in hamulus, M = 11.10 ± 0.280; flagellar segment 2/segment 1, M = 1.69 ± 0.029.

Structure and color: Color as in female with the following differences: clypeus pale yellow except dark spots at tentorial pits; labrum cream-colored except narrow dark brown apical margin; mandible usually with large triangular basal yellow spot, often reduced but rarely absent; flagellum yellow below, except basal half to two thirds of first segment, dark brown above; eyes green to blue; terga 1-6 with apical margins (beneath pale pubescence) hyaline, usually colorless, occasionally yellowish. First flagellar segment with minimum length equal to half of maximum length of second segment or more (Fig. 12); penultimate flagellar segment approximately two-thirds as broad as long; antennae reaching base of first metasomal tergum in repose. Integumental sculpturing and structure as in female with the following differences: clypeal punctures usually smaller; mesoscutum with posteromedian area usually with slightly more crowded punctures; metasomal terga with ground areas shiny, with extremely fine and sparse shagreening or none at all. Pygidial plate with apical portion at least as broad as half of base of plate and usually much broader.

Gonostylus capitate and slightly pointed inwards; inner surface of gonocoxite just below gonostylus with abundant short acute hairs and few blunt hairs admixed; penis valve with abundant short hairs on lateral surface below dorsal lamella (see LaBerge, 1956, Figs. 118 to 121). Sternum 7 with median plate with thick short neck, flat apical margin, and blunt apex directed posterolaterally, inner margin straight, slanted inwards towards apex, with abundant short hairs ventrally. Sternum 8 truncate apically with several relatively long hairs at apex, median ventral carina well separated from apex, short, blunt, not bilobed apically.

Hair: Much as in female but generally paler; hairs of head, thorax and legs never dark brown except occasionally with a few brown hairs on vertex of head, in posteromedian area of mesoscutum and medially on scutellum; metasomal hairs as in female but distal band of tergum 2 not interrupted and usually reaching apex medially, tergum 5 with pale distal band as on tergum 4, and terga 6 and 7 with long pale hairs; legs with yellow to red hairs on inner surfaces of tarsi, otherwise white. Often all pale hairs are golden yellow rather than being white; the former bees are considered to be newly emerged, or at least young adults, and the latter are considered to be older faded specimens.

Bionomics: Nothing has been published concerning the nesting habits of this species. Little is known concerning its flower preferences, but from the available records it appears that *M. dagosa* is a polylectic bee and visits a large variety of plants for pollen as well as for nectar. Females have been taken from plants of the families Asclepiadaceae, Leguminosae, Compositae and Cruciferae in that order of abundance. The only records on composites, however, are from thistles, whereas three genera of crucifers have yielded females of this species. *M. dagosa* is probably important in the pollination of alfalfa at least in Utah where this bee seemingly is most abundant.

Type material: Holotype male of *dagosa* from Osborn's Ranch, Grand Coulee, Washington, is the property of the California Academy of Sciences but temporarily deposited in the collection of the Citrus Experiment Station, Riverside, California. The holotype female of *calloleuca* from Saltair, Utah, is in the California Academy of Sciences, San Francisco, California.

Distribution: This species is widespread in the Rocky Mountains from southern Idaho and Washington in the north to middle eastern California in the southwest and the western half of Colorado in the east. It has been collected from May 19 to August 8 but mainly in June and July. In addition to the type material, 133 females and 184 males have been examined from the localities listed below. Localities mentioned in the literature and localities of the type material are included.

CALIFORNIA: Big Pine, Inyo Co.; Bridgeport, Mono Co.; Cedarville, Modoc Co.; Deep Springs, Inyo Co.; Diaz Lake, Inyo Co.; Lone Pine, Inyo Co.; Mammoth Lakes, Mono Co.; Topaz, Mono Co.; Wendel, Lassen Co.; Westgard Pass (7 miles W.), Inyo Co. COLORADO: Alamosa; Boulder; Delta; Eckert; Monte Vista. IDAHO: Aberdeen (5 miles N.); Hot Springs, Owyhee Co. NEVADA: Connor's Pass, White Pine Co.; Dumphy; Fallon; Lovelock; Reno (Sky Ranch). OREGON: Warner Lake, Lake Co.; Harney Co.; Steen Mts., Harney Co.; Umapine; Vale. UTAH: Callao; Cedar Mts. (S.E. end of), Tooele Co.; Delta; Dugway Parade Ground (S. E. of Camel Back Mt.), Tooele Co.; Elberta; Erda; Fillmore; Fish Springs; Fort Duchesne; Gandy; Grantsville; Hinckley; Jensen (10 miles E.); Kelton; Layton; Lehi; Little Salt Lake, Iron Co.; Lynndyl; McCormick; Milford; Nephi; Parowan; Park Valley; Payson; Penrose; Promontory; Saltair; South Fork, Ogden River; West Point. WASHINGTON: Grand Coulee (Osborn's Ranch); Lind; North Yakima; Yakima City. WYOMING: Carbon Co.; Green River; New Castle.

Flower records: Asclepias sp., *Cirsium* sp., *Medicago sativa, Melilotus* sp., *M. alba, Norta altissima, Sphaeralcea* sp., *Thelypodium brachycarpa.*

Melissodes (Tachymelissodes) opuntiella Cockerell

Melissodes opuntiella Cockerell, 1911, Canadian Ent., vol. 43, p. 131.
Melissodes albocincta Cockerell, 1919, Ann. Mag. Nat. Hist., ser. 9, vol. 2, p. 119 (new synonymy).

This is the smallest species of this subgenus. It differs from *M. dagosa* in both sexes by the clypeal and pubescence characters described in the diagnosis of the latter. Females of *opuntiella* can be distinguished from those of *sphaeralceae* by the punctation of the metasoma and thorax as described below. Males of *opuntiella* differ from those of *sphaeralceae* in having a pygidial plate similar to that of *dagosa* and by usually having an all yellow clypeus (partly black in a few specimens).

Female: Measurements and ratios: N, 20; length, 8-9 mm.; width, 3-4 mm.; wing length, M = 2.85 ± 0.016 mm.; hooks in hamulus, M = 10.25 ± 0.138; flagellar segment 1/segment 2, M = 2.15 ± 0.047.

Structure and color: Integumental color as in *M. dagosa* except as follows: apices of terga 2-4 broadly hyaline, colorless to yellow and apex of tergum 1 narrowly hyaline, colorless, hyaline area of tergum 1 equals about half of hyaline area of tergum 2 medially; wing membranes clear; tegulae piceous to clear yellowish brown.

Integumental sculpturing as in *M. dagosa* except as follows: clypeus with small round regular punctures usually separated by less than one puncture width, without markedly elongated punctures; maxillary palpal segments in ratio of about 3.6:2.25:2.1; mesoscutum with punctures smaller but distributed as in *dagosa*; propodeum dulled dorsally by dense fine irregular rugae and dense fine tessellation; metasomal tergum 1 with basal ⅗ to ⅘ with minute, round punctures separated mostly by one puncture width basally to two to four puncture widths apically, ground area dulled by exceedingly minute and dense shagreening; terga 2-4 with small round widely spaced punctures in areas basal to apical pubescent bands, ground areas opaque, dulled by exceedingly fine and dense shagreening.

Hair: Color as in *M. dagosa* with the following differences: Hairs of head and thorax white except occasionally pale brown in posteromedian area of mesoscutum; metasomal tergum 2 with apical pale band not interrupted or separated from apex of tergum medially; hairs of interband zones of terga 2-4 shorter and usually pale brown; basal band of tergum 3 white and of tergum 4 pale brown to white; terga 5 and 6 with lateral tufts of white hairs small or absent; hairs of legs white except as follows: on hind tibiae pale yellow, on inner surfaces of hind basitarsi yellow to red, on inner surfaces of fore and middle tarsi red, on outer surfaces of fore tarsi brown to red.

Male: Measurements and ratios: N, 20; length, 7-9 mm.; width, 2.5-3.0 mm.; wing length, M = 2.64 ± 0.167 mm.; hooks in hamulus, M = 9.60 ± 0.197; flagellar segment 2/segment 1, M = 1.73 ± 0.032.

Structure and color: Integumental color as in *M. dagosa* except as follows: labrum entirely black; basal mandibular yellow spot always large; clypeus occasionally blackened posteriorly. Structure as in *M. dagosa* with the following differences: antennae not surpassing propodeum in repose, penultimate flagellar segment ¾ to ⅘ as broad as long; clypeal punctation and maxillary palpi as in female; sculpturing of terga as in female but punctures slightly larger and more abundant.

Genital capsule as in *M. dagosa* but gonostylus usually less capitate and with fewer hairs on dorsal and outer surfaces, penis valves with fewer hairs laterally and gonocoxite with more abundant blunt hairs on inner surface near apex. Sternum 7 with median plate long-necked, oval in outline and with few minute hairs ventrally; apodeme not capitate at apex (Fig. 1). Sternum 8 emarginate at apex, with a distinct median ventral carina, narrower than in *M. dagosa* and distinctly narrower medially than at level of upper fourth (Fig. 2).

Hair: Much as in *M. dagosa* but paler; never with brown hairs on head or thorax; never with hairs golden yellow, but occasionally pale ochraceous on dorsum of head and thorax.

Bionomics: In keeping with its name this species shows some preference for pollen of cacti of the genus *Opuntia.* However, the few flower records available show that *M. opuntiella* will take pollen from other sources such as the legume *Lindheimera texana,* the mallow *Sphaeralcea pedatifida* and the composites *Cirsium* sp. and *Verbesina encelioides.* This variety of flowers bespeaks a rather polylectic species rather than the oligolecty inferred in its name.

Type material: Holotype male and allotype female of *opuntiella* from Brownsville, Texas, October 23, 1908, Jones and Pratt collectors, on *Opuntia lindheimeri* are in the U. S. National Museum (U. S. N. M. Type No. 14105). Unfortunately, the allotype female is not conspecific with the holotype male but belongs to the following species, *M. sphaeralceae.* The holotype female of *albocincta* from Mexico is in the U. S. National Museum (U. S. N. M. Type No. 23218).

Distribution: This species ranges from southern Utah and southern California in the northwest to eastern Texas and northeastern Mexico in the southeast. It has been collected from March 25 to October 23 but mainly during April and May. In addition to the type material, 49 females and 34 males have been examined from the localities listed below.

ARIZONA: Wickenburg. CALIFORNIA: Hopkins Well (1.8 miles E.), Riverside Co. TEXAS: Brownsville; Corpus Christi; Cotulla; Dilley; Hidalgo; Kerrville; Laredo (2 and 18 miles N.); Pharr (10 miles S. W.); Progresso; Rio Grande (6 miles E. and 20 miles S. E.); San Diego; San Ygnacio; Sonora; Uvalde. UTAH: Heber. COAHUILA: San Pedro de Colonias (3700 feet altitude).

Flower records: Cercidium texanum, Cirsium sp., *Helenium microcephalum, Helianthus annuus, Lindheimeri texana, Opuntia* sp., *O. lindheimeri, Parkinsonia* sp., *Prosopis* sp., *Sphaeralcea* sp., *S. pedatifida, Verbesina encelioides.*

Melissodes (Tachymelissodes) sphaeralceae Cockerell

Melissodes sphaeralceae Cockerell, 1896, Entomologist, vol. 29, p. 304; 1897, Bull. New Mexico Coll. Agric. and Mech. Arts, no. 24, p. 20; 1898, Bull. Sci. Lab. Denison Univ., vol. 11, p. 66; 1902, Entomologist, vol. 35, p. 177; 1904, Entomologist, vol. 37, p. 8; 1906, Trans. Amer. Ent. Soc., vol. 32, pp. 75, 86; 1906, Trans. Amer. Ent. Soc., vol. 32, p. 309.

This species is closely related to *M. opuntiella.* The males can readily be distinguished by the form of the pygidial plate as described below. The female can be separated from the female of *dagosa* by the finer punctation of the clypeus and from the female of *opuntiella* by the large patch of brown hairs on the mesonotum and by the more coarsely punctate metasomal terga as described below.

Female: Measurements and ratios: N, 12; length, 9-11 mm.; width, 3-4 mm.; wing length, $M = 3.08 \pm 0.230$ mm.; hooks in hamulus, $M = 11.41 \pm 0.244$; flagellar segment 1/segment 2, $M = 2.44 \pm 0.049$.

Structure and color: Integumental color as in *M. dagosa* with the following differences: eyes gray to grayish blue; tegulae piceous but clear brown posteromedially; tergum 1 with a broad colorless hyaline apical margin; terga 2-4 (beneath apical pubescent bands) hyaline, colorless or yellow; wing membranes clear or somewhat milky apically.

Clypeus finely and regularly punctate, punctures round, separated mostly by half of one puncture width or less, ground areas smooth and shiny; supraclypeal area with round punctures similar to those on adjacent portion of clypeus, ground areas smooth and shiny; galeae as in *M. dagosa*; maxillary palpal segments in ratio of about 2.5:2:2:1. Mesoscutum with large round punctures separated by one to four puncture widths posteromedially and by half of a puncture width or less anteriorly and laterally, ground areas shiny, often with exceedingly fine reticulate shagreening; scutellum similarly sculptured but punctures distinctly smaller than on mesoscutum; metanotum and mesepisterna sculptured as in *dagosa;* propodeum as in *dagosa* but dorsal surface with large distinct punctures. Metasomal tergum 1 with basal ⅗ or slightly more with small round punctures, in basal half punctures separated mostly by less than one puncture width, distal to these punctures more widely separated (especially laterally) except for a single row of close-set punctures extending across tergum at about ⅗ distance from base, ground areas moderately shiny, dulled by exceedingly fine transverse shagreening; interband zones of terga 2 and 3 with round, irregularly spaced punctures of irregular size, separated from nearest neighbors by less than half to four puncture widths (sparser medially than basally or apically), punctures crowded beneath basal pubescent band and beneath basal portion of apical pubescent band, ground areas as in tergum 1; tergum 4 with interband zone more densely punctate than in terga 2 or 3.

Hair: On head and thorax white except long brown hairs on vertex of head between apices of compound eyes, mesoscutal patch of brown hairs which extends forwards well beyond a transverse line at anterior margins of tegulae and scutellum with large median brown hair patch. Metasomal terga with hairs as in *dagosa* with the following differences: hairs of interband zones shorter and more appressed, basal band of tergum 3 pale, distal pale bands of terga 2 and 3 consisting of much shorter, appressed pubescence, that on tergum 2 not interrupted and reaching apex medially. Hairs of legs white except as follows: ochraceous or pale brown distally on middle tibiae and basally on hind tibiae, orange to yellow on inner surfaces of tarsi and tibiae; scopal hairs with 4 to 10 branches on either side of rachis.

Male: Measurements and ratios: N, 19; length, 9-10 mm.; width, 2.0-3.5 mm.; wing length, M = 3.32 ± 0.247 mm.; hooks in hamulus, M = 10.47 ± 0.183; flagellar segment 2/segment 1, M = 1.79 ± 0.010.

Structure and color: Integumental color as in *M. dagosa* with the following differences: clypeus partially or wholly black; mandible with large basal yellow spot never reduced or absent; labrum black; eyes gray or grayish blue.

Minimum length of first flagellar segment equals more than half of maximum length of second segment; penultimate flagellar segment approximately half as broad as long; antennae barely reaching base of first metasomal tergum in repose; galeae and maxillary palpi as in female. Sculpturing as in female with the following differences: punctation of terga usually somewhat denser, ground areas of interband zones occasionally dulled by dense shagreening. Pygidial plate with apical portion less than half as broad as base of plate and often as narrow as a third basal width.

Gonostylus capitate as in *dagosa,* otherwise capsule as in *opuntiella.* Sternum 8 as in *opuntiella* but median ventral carina sharper and hairs at apex of sternum somewhat more abundant. Sternum 7 as in *opuntiella.*

Hair: On head and thorax as in female but often without brown hairs on vertex and mesoscutal brown patch usually smaller and occasionally absent. Metasomal hairs as in female but tergum 5 with distal pale band as in terga 2-4, tergum 6 usually without lateral tufts of pale hairs and sternal hairs all white. Legs with white hairs except orange to yellow on inner surfaces of tarsi. Body hairs not golden yellow as in *dagosa* on any specimens now before me.

Type material: Lectotype male of *sphaeralceae,* here designated, from Santa Fe, New Mexico, July, is in the collection of the University of Colorado Natural History Museum, Boulder, Colorado.

Distribution: This species ranges from Durango, Mexico, and Brownsville, Texas, north to the Sandia Mountains in New Mexico, and west to Arizona. It has been taken from June 23 to September 4, but mainly in July and August. In addition to the lectotype, 20 males and 12 females have been examined from the localities listed below. This list includes localities reported in the literature.

ARIZONA: Navajo Co. NEW MEXICO: Pecos, San Miguel Co.; Sandia Mountains; Santa Fe. TEXAS: Brownsville. DURANGO: Nombre de Dios; Yerbanis (Cuencame District). HIDALGO: Ixmequilpan. DISTRITO FEDERAL: Guadalupe; México (city).

Flower records: Monarda sp., *Sphaeralcea* sp., *S. angustifolia, S. fendleri.*

Subgenus *Apomelissodes* LaBerge

Apomelissodes LaBerge, 1956, Univ. of Kansas Sci. Bull., vol. 37, p. 1175.

Type species: Melissodes fimbriata Cresson, 1878, by original designation.

This subgenus, originally intended to include two species (*M. fimbriata* Cresson and *M. apicata* Lovell and Cockerell) which occur in southeastern United States, now includes four species. *Melissodes baileyi* Cockerell is provisionally included at this time and a new species is described below. *M. baileyi* is known from a single female which does not have a protruding clypeus, long galeae or hooked galeal hairs. The first couplet in the key to the subgenera of *Melissodes* (females) published previously (LaBerge, 1956, p. 922) should accordingly be changed to read as follows:

1. Scopal hairs simple or weakly branched, *if* weakly branched, *then* clypeus in profile protruding beyond eye by ⅔ width of eye or more .... *Apomelissodes*

Scopal hairs branched, usually abundantly so, *if* weakly branched, *then* clypeus in profile not protruding beyond eye by as much as ⅔ width of eye 2

KEY TO THE SPECIES OF THE SUBGENUS APOMELISSODES

Males

1. Galeae (measured from base of first palpal segment) three times as long as clypeus or longer; pygidial plate notched laterally but not so deeply as to create the impression of two plates; apical pubescent bands of terga 2-5 consist of one to three rows of long silky short-branched hairs arising slightly anterior to one hair length from margins of terga .... *fimbriata*

Galeae considerably less than three times as long as clypeus; pygidial plate deeply notched laterally, often appearing like two plates (a large high anterior plate and a small posterior plate on a lower level); apical pubescent bands of terga 2-5 consist of several rows of short, highly plumose hairs arising in a broad zone from bases of bands almost to margins of terga 2

2. Clypeus yellow except black notches posteriorly at tentorial pits, coarsely punctate with median zone impunctate and moderately shiny; galeae with sparse short hairs laterally .... *mitchelli*

Clypeus all or partly black, densely punctate and dull; galeae with abundant short hairs laterally .... *apicata*

Females

1. Scopal hairs simple, unbranched 2

Scopal hairs weakly branched 3

2. Galeae three times as long as clypeus or longer .... *fimbriata*

Galeae two times as long as clypeus or less .... *baileyi*

3. Galeae with sparse short straight hairs laterally; clypeus with posteromedian area slightly depressed or flattened, sparsely and coarsely punctate .... *mitchelli*

Galeae with abundant long hooked hairs laterally; clypeus with posteromedian area not depressed or flattened, densely and coarsely punctate .... *apicata*

Melissodes (Apomelissodes) fimbriata Cresson

Melissodes fimbriata Cresson, 1878, Proc. Acad. Nat. Sci., Philadelphia, vol. 30, p. 203; Fox, 1892, Ent. News, vol. 3, p. 29; Birkman, 1899, Ent. News, vol. 10, p. 245; Cockerell, 1906, Trans. Amer. Ent. Soc., vol. 32, pp. 77, 87; Smith, 1910, Ann. Report New Jersey State Museum, 1909, p. 693; Cresson, 1916, Mem. Amer. Ent. Soc., vol. 1, p. 118; Brimley, 1938, Insects of North Carolina, p. 462.

Melissodes perplexa, Cresson, 1878, Proc. Acad. Nat. Sci., Philadelphia, vol. 30, p. 206 (misidentification of male).

Melissodes fimbriata is easily separated in both sexes from the other members of this subgenus by use of the characters listed in the key given above. Several other striking distinctions exist and are described below.

Female: Measurements and ratios: N, 18; length, 11.0-13.0 mm.; width, 4.0-5.0 mm.; wing length, M = 21.38 ± 0.381 mm.; hooks in hamulus, M = 15.56 ± 0.271; flagellar segment 1/segment 2 (N, 16), M = 1.95 ± 0.002.

Structure and color: Integument black except as follows: lower surfaces of flagellar segments 2-10, apical half of mandible, legs (or at least distitarsi) and sterna (at least apically) dark reddish brown; apical half of mandible usually with median golden macula; eyes bluish gray to green; tegulae piceous; wing membranes somewhat infumate, yellow or yellowish brown, veins dark brown to black.

Clypeus with small deep round dense regular-sized punctures separated by half a puncture width or less, ground areas shiny, unshagreened except sparsely so laterally and posteriorly; supraclypeal area densely punctate laterally, sparsely punctate medially, ground areas medially dulled by fine tessellation; flattened area of vertex between compound eye and lateral ocellus densely punctate, punctures deep, round, separated by one puncture width or less; galeae from base of first palpal segment to tips equal 3.5 to 4.0 times median length of clypeus, with exceedingly sparse short straight hairs scattered over surface, ground moderately shiny above, dulled laterally and below by reticular shagreening; maxillary palpal segment in ratio of about 2.75:3.5:3:1. Mesoscutum with small round punctures separated mostly by one puncture width or less posteromedially and less than half a puncture width anteriorly and peripherally, ground areas shiny, unshagreened; scutellum as densely punctate as posterior declivous portion of mesoscutum; mesepisterna with punctures slightly larger than on anterior half of mesoscutum, separated mostly by half a puncture width or less, ground areas shiny, unshagreened; metanotum densely punctate medially, less so laterally, shiny, slightly shagreened laterally; propodeum with dorsal surface with large coarse punctures except medially, moderately shiny, surface dulled by irregular tessellation, with posterior surface densely and coarsely punctate except medially, dulled by irregular tessellation except dorsomedial area, with lateral surface densely and coarsely punctate, ground areas moderately shiny to shiny. Metasomal tergum 1 sparsely punctate in basal ⅗ of dorsal surface, punctures shallow, becoming denser anteriorly and laterally, ground dulled by coarse reticulotransverse shagreening; tergum 2 with interband zone sparsely punctate, punctures shallow and separated mostly by 2 puncture widths or more, with apical area impunctate except for row of dense punctures near anterior margin of apical pale band, with basal area densely punctate, ground areas dulled as in tergum 1; terga 3 and 4 as in tergum 2, but interband zones progressively more densely punctate.

Hair: On head white, occasionally a few long dark brown hairs on vertex behind median ocellus. Thorax with white hairs except large mesoscutellar patch of dark brown to black hairs which extends forward beyond a transverse line at anterior margins of tegulae and scutellar hairs dark brown to black except posterior and lateral fringes of white hairs; tegulae and humeral angles of wings with abundant dark brown hairs. White hairs in basal ⅗ of dorsal surface of metasomal tergum 1 extend to apex laterally, bare apicomedially; tergum 2 with basal band of white highly plumose pubescence, with apical band of white pubescence composed of long, silky hairs with short branches, with interband zone with abundant erect or suberect bristlelike white short hairs which are longer at extreme sides; terga 3 and 4 similar to tergum 2 but basal pubescent bands dark brown, apical bands denser and bristlelike hairs all or mostly dark brown and longer; terga 5 and 6 with long appressed dark-brown hairs, usually with small tufts of white hairs at extreme sides of tergum 5; sternal hairs reddish brown basally and medially, white apicolaterally. Legs with hairs white except as follows: outer surfaces of fore tarsi, outer surfaces of middle and hind distitarsi, basally on hind tibiae and apically on fore and middle tibiae brown; inner surfaces of tarsi and hind tibiae yellow to orange-red; scopal hairs simple, white to ochraceous.

Male: Measurements and ratios: N, 20; length, 9.0 to 13.0 mm.; width, 3.0-4.5 mm.; wing length, M = 21.34 ± 0.369 mm.; hooks in hamulus, M = 13.55 ± 0.271; flagellar segment 1/segment 2, M = 4.20 ± 0.256.

Structure and color: Integument black except as follows: clypeus yellow except black notches posteriorly at tentorial pits, occasionally posterolateral angles (mesad to tentorial pits) darkened and apical margin dark reddish brown; labrum usually black, rarely with small posteromedial yellow spot; mandible as in female; lower surfaces of flagellar segments 2 to 11, distitarsi and apical margins of sterna dark reddish brown; eyes gray to bluish gray; wing membranes somewhat infumate yellowish brown, veins dark brown to black.

Galeae long as in female; maxillary palpi as in female; minimum length of first flagellar segment equals ¼ to ⅕ of maximum length of second segment. Sculpturing of head and mesosoma as in female. Sculpturing of metasoma as in female except as follows: tergum 1 with basal ⅘ to ⅚ densely punctate; terga 2-5 with interband zones somewhat more densely punctate, medially on tergum 2 punctures separated mostly by one to two puncture widths; pygidial plate flat, notched laterally at about a third of length from apex, apical portion about ⅔ width of basal portion or more; sternum 6 shiny, shallowly grooved medially, slightly emarginate apically, with coarse, round punctures separated by one puncture width or less on each side of median groove.

Terminalia described and figured by LaBerge (1956, Figs. 111-113). Sternum 7 with median plate long-necked. Sternum 8 pointed medioapically.

Hair: Color as in female with the following differences: vertex of head without dark hairs; long white hairs of metasomal tergum 1 reach apex; terga 2-5 with apical fringes of long white silky short-branched pubescence arising in one to three rows at about the length of one hair from apices of terga; terga 3-5 with abundant erect bristlelike hairs in interband zones, those of tergum 2 white; terga 6 and 7 with long dark-brown appressed hairs; sternal hairs white to ochraceous except reddish brown posteromedially on sterna 2-5 and dark brown on sternum 6. Legs with white hairs except yellow to orange on inner surfaces of tarsi and hind tibiae.

Bionomics: The evidence available from labels on the specimens indicates that *M. fimbriata* is an oligolectic bee dependent upon plants of the genus *Oenothera* (Onagraceae) for pollen as well as nectar. Out of 15 collections with flower data, 13 are from *Oenothera,* whereas the other two consist each of one male, the first from *Kneiffia* sp. (Onagraceae) and the second from *Helianthus petiolaris* (Compositae).

Type material: Female lectotype and male lectoallotype of *fimbriata* from Texas are in the Academy of Natural Sciences of Philadelphia, Pennsylvania. The lectoallotype male of *perplexa* from Georgia is, unfortunately, not conspecific with the lectotype female, but is the same as the male lectoallotype of *fimbriata.*

Distribution: This species ranges from Virginia in the northeast to Georgia in the southeast, west to Texas and northwest to southwestern Kansas. It has been collected from April 25 to July 27. In addition to the type material, 18 females and 27 males have been examined. These records are so widely and sporadically distributed that it is deemed best to list here the collection data in full.

GEORGIA: 1 ♂, lectoallotype of *M. perplexa* Cresson. KANSAS: Garden City, 1 ♂, June 3, 1952, Cheng Liang; Tribune, 1 ♂, June 16, 1949, C. D. Michener and R. H. Beamer, on *Helianthus petiolaris.* MISSISSIPPI: Hattiesburg, 1 ♂, July 22, 1944, C. D. Michener; Mississippi State College, 1 ♂, April 26, 1949, 1 ♀, June 5, 1947, student collectors. NORTH CAROLINA: Burgaw, 2 ♀ ♀, May 18, 1950, T. B. Mitchell, on *Oenothera* sp.; Garford, 1 ♀, June 7, 1927, C. S. Brimley; Lexington (12 miles E.), 1 ♀, June 13, 1950, T. B. Mitchell, on *Oenothera* sp.; Merry Oaks, 1 ♂, July 27, 1926, T. B. Mitchell, on *Oenothera* sp.; Raleigh, 1 ♀, May 25, 1922, on *Oenothera* sp.; 2 ♂ ♂, July 18, 1922, on *Oenothera* sp., 1 ♂, July 20, 1927, on *Oenothera* sp., 1 ♀ and 1 ♂, May 23, 1929, on *Oenothera* sp., 2 ♀ ♀, May 25, 1929, on *Oenothera* sp., 2 ♀ ♀, May 25, 1933, on *Oenothera* sp., 1 ♂, July 7, 1933, on *Oenothera* sp., 1 ♂, May 26, 1935, 1 ♀, May 15, 1938, on *Oenothera laciniata,* 1 ♀, May 29, 1938, 1 ♂, May 15, 1939, 1 ♀, April 25, 1942, 1 ♂ and 2 ♀ ♀, May 29, 1950, on *Oenothera* sp., 4 ♂ ♂, May 17, 1951, on *Oenothera* sp., T. B. Mitchell; Willard, 2 ♂ ♂ and 1 ♀, May 11, 1951, T. B. Mitchell. TEXAS: Kerrville, 1 ♂, May 22, 1908, F. C. Pratt; 1 ♂, "Collection T. Pergande"; 3 ♂ ♂, "Collection Belfrage". VIRGINIA: Dawson's Beach, 1 ♂, June 6, 1931, on *Kneiffia* sp., J. C. Brimwell. A single male in the collection of the Illinois Natural History Survey is labeled "Tamarack Bog" with the numeral 4 above.

Melissodes (*Apomelissodes*) *baileyi* Cockerell

Melissodes baileyi Cockerell, 1906, Ann. Mag. Nat. Hist., ser. 7, vol. 17, p. 361.

This species, known only from the female holotype, seemingly is closely related to *M. fimbriata.* It is similar to the latter in having simple scopal hairs, but differs in having a relatively flat clypeus and short galeae. It can be separated from the female of *M. apicata* by the lack of abundant hooked galeal hairs. If it were not for the simple scopal hairs, *M. baileyi* would probably be placed in the subgenus *Tachymelissodes.* However, the simple scopal hairs, together with the form of the metasomal pubescence, seems to relate this species to *M. fimbriata* and it is, accordingly, placed in the subgenus *Apomelissodes.* Study of the male terminalia will undoubtedly solve this problem.

Female: Measurements and ratios: N, 1; length, 11.0 mm.; width, 4.0 mm.; wing length, 3.33 mm.; hooks in hamulus, 13; flagellar segment 1/segment 2, 1.97.

Structure and color: Integument black except as follows: Mandible dark reddish brown in apical ¾, apical half with large median golden macula; flagellar segments 3 to 10 red beneath; eyes gray; legs and sterna dark reddish brown; metasomal tergum 1 with apical margin hyaline, colorless; tegulae piceous; wing membranes hyaline, colorless, veins dark brown.

Clypeus with dense round punctures of regular size separated mostly by half of one puncture width or less, ground areas moderately shiny; supraclypeal area impunctate medially, shiny, coarsely punctate laterally; flattened area of vertex posteromesad of apex of compound eye with abundant round punctures of irregular size separated mostly by one puncture width or less, ground shiny; galeae about twice as long as median length of clypeus, shiny, unshagreened above or only delicately so, with sparse, short, straight hairs and sparse punctures; maxillary palpi 4-segmented, segments in ratio of about 2.5:2:2:1. Mesoscutum with small round punctures separated by one or slightly more puncture widths posteromedially and by half a puncture width in anterior half and peripherally; scutellum with small punctures of about same size as on adjacent part of mesoscutum, separated by one to half of one puncture width medially and less peripherally; ground areas of mesoscutum, scutellum and mesepisternum shiny, unshagreened; mesepisternum with large shallow punctures separated by half of one puncture width or less, many punctures not well defined posteroventrally; metanotum with abundant small punctures half size of punctures on posterior part of scutellum or a little larger, dense medially, sparse laterally, ground shiny medially and dull laterally; propodeum with dorsal surface reticulorugose except medially, with a few large punctures posteriorly, surface dulled by dense fine tessellation, with posterior surface densely punctate except upper median impunctate triangle, ground areas dulled by dense tessellation. Metasomal tergum 1 with dorsal surface punctate in basal half, punctures separated by one to two puncture widths apically in median half and by half a puncture width or less basally and laterally to apex, ground areas moderately shiny, with dense coarse transverse shagreening; tergum 2 with interband zone with exceedingly small punctures, almost impunctate medially but separated by one puncture width or less laterally, apical area impunctate, basal area densely punctate, ground areas opaque, dulled by dense fine transverse shagreening; terga 3 and 4 similar to tergum 2 but more densely punctate in interband zones.

Hair: On head white; mesosomal hairs white except as follows: mesoscutellar patch of dark brown hairs extending forward to a transverse line at anterior margins of tegulae, scutellar hairs dark brown except peripherally. Metasomal tergum 1 with long white hairs in basal half medially and to apex laterally; tergum 2 with basal band of white pubescence, apical band of long white silky short-branched pubescence, interband zone of short simple bristle-like dark-brown hairs about equal in width to apical pale band, apical and basal pale bands connected laterally by white erect hairs; terga 3 and 4 similar to tergum 2 but basal bands dark brown; terga 5 and 6 with long dark-brown hairs, with long white tufts laterally on tergum 5; sternal hairs reddish brown except white apicolateral hairs on each sternum but the first and last. Legs with white hairs except as follows: brown on outer surfaces of fore tarsi, distally on fore and middle tibiae and basally on hind tibiae, yellow to orange on middle and hind basitarsi and hind tibiae; scopal hairs simple, unbranched, white to pale yellow.

Type material: Holotype female of *baileyi* from Fedor, Lee County, Texas, April 5, 1904, Rev. G. Birkman coll., is the property of the California Academy of Sciences, San Francisco, California, but is temporarily deposited in the collection of the Citrus Experiment Station, Riverside, California.

Melissodes (*Apomelissodes*) *apicata* Lovell and Cockerell

Melissodes apicata Lovell and Cockerell, 1906, Psyche, vol. 13, p. 111.

This species is very distinct from the other species in this subgenus. The female of *apicata* can be recognized by the protruding clypeus, the weakly branched scopal hairs, the short galeae and the abundant long hooked galeal hairs. The males can be distinguished by the short galeae which bear abundant short straight hairs laterally, the peculiar pygidial plate described below and the all or partially black clypeus. In addition, both sexes often have three-segmented maxillary palpi, a feature unique in the genus *Melissodes.*

Female: Measurements and ratios: N, 20; length, 11.0-14.0 mm.; width, 4.0-5.5 mm.; wing length, M = 21.56 ± 0.252 mm.; hooks in hamulus, M = 13.85 ± 0.379; flagellar segment 1/segment 2, M = 1.98 ± 0.075.

Structure and color: Integument black except as follows: mandible with apical half red with median golden macula; eyes gray to bluish gray; flagellar segments 2 to 10 beneath slightly reddish; distitarsi and often basitarsi, tibiae and femora and occasionally sterna reddish brown; wing membranes somewhat infumate to deeply so, brown, veins black; tegulae piceous; metasomal tergum 1 often narrowly hyaline apically.

Clypeus strongly protuberant, with coarse, irregular-sized punctures separated mostly by half a puncture width or less, with irregular, longitudinal, median carina in apical half or less, ground areas shiny, unshagreened; supraclypeal area coarsely punctate, ground area shiny; vertex with flattened areas mesad of apices of compound eyes coarsely punctate, punctures large, separated mostly by less than half a puncture width, ground areas shiny, unshagreened; galeae shiny, unshagreened, with abundant small punctures especially laterally, length less than three and more than two times median clypeal length; maxillary palpal segments usually three in ratio of about 4.0:4.0:2.5, occasionally a minute fourth segment present. Mesoscutum with abundant round punctures separated by half to one and a half puncture widths posteromedially and by half a puncture width or less anteriorly and peripherally, ground areas shiny, unshagreened; scutellum with punctures about same size as on adjacent part of mesoscutum, separated by half a puncture width or less, ground areas shiny, unshagreened; mesepisternum with large shallow punctures mostly larger than those of posteromedial area of mesoscutum and separated mostly by less than a third of one puncture width, ground areas shiny to moderately so, bottoms of punctures etched by reticulate shagreening; metanotum with abundant crowded punctures medially, sparser laterally, punctures separated by half a puncture width or less, smaller than those in middle of scutellum, ground areas shiny medially, shagreened laterally; propodeum with dorsal surface weakly reticulorugose except in median sixth, ground areas opaque, tessellate, with posterior surface sparsely punctate except broad, upper, impunctate triangle, ground dulled by tessellation but impunctate triangle usually moderately shiny. Metasomal tergum 1 with basal 3/5 weakly punctate, punctures small, round, shallow, separated by one to two puncture widths apically and by less than one width basally and laterally, ground areas moderately shiny, with fine transverse shagreening; tergum 2 with minute punctures in interband and basal zones, punctures separated mostly by two puncture widths but somewhat more crowded laterally, with apical area impunctate, ground areas moderately shiny to dull, transversely and densely shagreened; terga 3 and 4 similar to tergum 2 but punctures more abundant especially in basal areas.

Hair: On head white except abundant long black or dark brown hairs on vertex between apices of compound eyes and on face almost to antennae; galeae with abundant long hooked hairs, especially laterally. Mesosoma with white hairs except large mesoscutellar patch of dark brown to black hairs which extends forward beyond a transverse line at anterior margins of tegulae and often almost reaches pronotum, posterior lobes of pronotum with abundant long black hairs mixed with the pale, tegulae and humeral angles of wings with dark brown hairs, scutellum with hairs dark brown to black except long white hairs peripherally. Metasomal tergum 1 with long white hairs in basal half to three fifths and to apex at extreme sides; tergum 2 with basal and apical bands of white pubescence connected at extreme sides, apical band with sinuate anterior margin and almost interrupted medially, interband zone with abundant black or dark brown, erect or suberect, bristlelike hairs, apical band consists of several rows of short highly plumose hairs; terga 3 and 4 with basal bands of dark brown to black tomentum, with apical bands of white pubescence similar to that of tergum 2 but not sinuate anteriorly and with abundant dark brown bristlelike hairs in interband zones; terga 5 and 6 with long dark brown to black appressed hairs and with lateral tufts of long white hairs on tergum 5; sternal hairs brown except white at extreme sides near apices of all but first and last sterna. Legs with white hairs except as follows: outer surfaces of fore tarsi, apices of fore and middle tibiae, bases of hind tibiae and basitibial plates brown; inner surfaces of tarsi yellow (especially distitarsi) to dark brown, inner surfaces of hind basitarsi usually reddish brown; scopal hairs weakly plumose, each with one to five branches on each side of rachis and usually three or four, more highly plumose on basitarsi than on tibiae, pale ochraceous to white, occasionally pale brown on tibiae.

Male: Measurements and ratios: N, 20; 10.0-13.0 mm.; width, 4.0-5.0 mm.; wing length, $M = 21.35 \pm 0.293$ mm.; hooks in hamulus, $M = 12.65 \pm 0.215$; flagellar segment 2/segment 1, $M = 6.11 \pm 0.118$.

Structure and color: Integument black except as follows: clypeus yellow or yellowish orange, with black apical margin and black posterior margin, posterior infuscation often extends forward to cover half or more of clypeus (one specimen entirely black); mandible with apical half red with median golden macula; flagellar segments 2-11 yellow to red beneath, dark brown above; eyes dark violet gray, gray, yellowish green, or bluish gray; distitarsi, often basitarsi and tibiae, occasionally femora and coxae dark reddish brown; wing membranes infumate, yellowish brown, veins dark brown to black, tegulae piceous.

Structural characters as in female with the following differences and addition: minimum length of first flagellar segment equals approximately ⅙ of maximum length of second segment, often less; metasomal tergum 1 punctate almost to apex medially; terga 2-5 with ground areas shiny to moderately so, weakly shagreened; pygidial plate deeply notched at about a third distance from apex to base, apical margin of apical portion and apicolateral margins of basal portion upturned, basal portion usually on a slightly higher level than apical portion so as to give the impression of two pygidial plates.

Genital capsule essentially as in *M. fimbriata* but penis valve with lateral process somewhat more acute (Figs. 3 and 4). Sternum 7 as in *fimbriata* but median plate larger, with more hairs ventrally and without a distinct neck but joined to sternum by almost its entire width, with lateral plates more rounded than in *fimbriata* (Fig. 5). Sternum 8 similar to that of *fimbriata* but with fewer, shorter hairs apicomedially and with numerous short hairs scattered over ventral surface in apical half (Fig. 6).

Hair: As in female with the following differences: with few or no brown hairs on vertex of head; galeal hairs abundant, especially laterally, but straight, not hooked; mesoscutal and scutellar patches of dark hairs usually somewhat smaller; metasomal tergum 1 with pale hairs extending to, or almost to, the apex; tergum 2 with apical white pubescent band not nearly interrupted medially, not sinuate anteriorly; terga 2-5 with narrow apical white bands subequal to each other in width and subequal in width across each tergum, with dark brown bristlelike hairs more abundant and longer; terga 6 and 7 with long brown hairs; sternal hairs largely white to ochraceous, darker basally on each sternum except the first and last, apices of sterna with fringes of long hairs white and highly plumose laterally and ochraceous to reddish brown medially; legs with white hairs except yellow to brown on inner surfaces of tarsi, occasionally brown on outer surfaces of hind basitarsi below basitibial plates and occasionally ochraceous on outer surfaces of tarsi and tibiae (especially hind tibiae).

Bionomics: This species is apparently oligolectic and restricted to plants of the genus *Pontederia* (family Pontederiaceae) for both pollen and nectar. The hooked galeal hairs of the female are probably an adaptation for removing pollen from the narrow tubular flowers of this plant. The longer galeae and protruding clypei to house them are probably adaptations for retrieving nectar from the deep nectaries of *Pontederia.*

Type material: Holotype female from Waldoboro, Maine, July 21, 1904, on *Pontederia cordata,* J. H. Lovell collector, is in the collection of the North Carolina State College, Raleigh, North Carolina.

Distribution: M. apicata occurs along the Atlantic coast from Maine to Florida. It has been collected from March 21 to July 21, but mainly in April and May. In addition to the holotype, 23 females and 45 males have been examined. The collection data for these are listed below in full, since this is a rare and poorly known species.

DISTRICT OF COLUMBIA: Washington, 2 ♂ ♂, July, 1901, J. C. Bridwell. FLORIDA: Alachua Co., 1 ♀ and 5 ♂ ♂, April 12, 1955, on *Pontederia* sp., 5 ♂ ♂, April 12, 1955, with no floral data, T. B. Mitchell, April 13, 1955, 2 ♂ ♂ on *Melilotus alba* and 2 ♂ ♂ on *Stachys floridana,* H. V. Weems Jr., April 12-13, 1955, 7 ♂ ♂ on *Melilotus alba,* R. A. Morse, April 15, 1955, 2 ♂ ♂, with no floral data, R. A. Morse, April 12, 1955, 1 ♂, on *Hydrocotyle umbellata,* R. A. Morse; Englewood, 1 ♀, April 8, 1944, J. G. Needham; Fort Ogden, 1 ♀, April 9, 1952, G. S. Walley; Gainesville, Alachua Co., 2 ♂ ♂, May 4, 1923, Alexander and Walker; Highlands Hammock State Park, 5 ♂ ♂, April 7, 1955, on *Pontederia* sp., T. B. Mitchell; Island Grove, 1 ♂, 1890; Jacksonville, 1 ♂, W. H. Ashmead collection; Lake Iamonia, 1 ♂, May 12, 1916, on *Pontederia cordata,* W. D. Pierce; Moon Lake, Pasco Co., 1 ♀, April 16, 1952, J. R. Vockeroth; Orlando, 1 ♀, April 4, 1955, taken on sand, K. V. Krombein; Osceola Co., 2 ♂ ♂, March 27, 1952, F. E. Lutz; Sarasota, 1 ♂, April 2, 1938, F. E. Lutz; Sebring, 1 ♂, March 25, 1938, F. E. Lutz. GEORGIA: Chauncey, 3 ♀ ♀ and 1 ♂, April 28, 1949, P. W. Fattig. MAINE: Waldoboro. MARYLAND: Mason Spring, 1 ♂, July 12, 1931, on *Pontederia cordata,* P. H. Timberlake. MASSACHUSETTS: Concord, J. Bequaert. NEW JERSEY: Atsion, 1 ♂, 4 ♀ ♀, July 9, 1955, on *Pontederia* sp., A. F. Shinn; Vineland, 1 ♂, Mourice River. NORTH CAROLINA: Wilmington, 8 ♀ ♀ and 1 ♂, May 20, 1934, on *Pontederia* sp., T. B. Mitchell. An additional female labeled "7-14-92" and "Ag. Coll. Mich." has been identified as of this species.

Melissodes (*Apomelissodes*) *mitchelli*, sp. nov.

This species is named in honor of T. B. Mitchell who collected five of the ten known specimens and who has contributed a great deal to the knowledge of the species of *Melissodes* by means of the specimens collected by him in the eastern states. *M. mitchelli* is closely related to *M. apicata* from which it can be distinguished by the characters appearing above in the keys. It is so much like *apicata* in appearance that a detailed description would largely be a repetition of the description of that species. The description which follows, therefore, is largely an innumeration of the characters in which *mitchelli* and *apicata* differ.

Female: Measurements and ratios: N, 6; length, 11.0-12.0 mm.; width, 4.0-4.5 mm.; wing length, $M = 21.15 \pm 0.161$ mm.; hooks in hamulus, $M = 13.83 \pm 0.374$; flagellar segment 1/segment 2, (N, 5) $M = 1.78 \pm 0.048$.

Structure and color: Integumental color as in *apicata.* Structure as in *apicata* with the following differences: clypeus with posteromedian area flattened or slightly depressed, with punctures small, round, and sparse medially almost to apical margin, ground shiny, unshagreened, punctures round, regular in size and shape laterally; galeae shiny, with sparse punctures bearing short straight hairs laterally; maxillary palpal segments four, in ratio of about 2.5:4:3:1; propodeum with dorsal face with broader impunctate zone medially; metasomal tergum 1 with basal ⅖ or less of dorsal surface punctate; terga 1-3 with ground areas dulled by fine, dense, transverse shagreening, duller than in *apicata;* pygidial plate ¾ as broad at extreme base than median length, distinctly broader than in *apicata.*

Hair: Color of hairs as in *apicata* with the following differences: vertex with black hairs less abundant; lobes of pronotum without dark hairs; dark mesoscutellar patch not almost reaching pronotum but extending forward to a transverse line at or beyond anterior margins of tegulae; tegulae and humeral angles of wings with pale hairs; metasomal tergum 2 with apical band separated from apex of tergum in median third or less and often narrowly interrupted medially; scopal hairs with one to three branches on either side of each rachis, never brown on tibiae except immediately below basitibial plates.

Male: Measurements and ratios: N, 4; length, 10.0-12.0 mm.; width, 3.5-4.0 mm.; wing length, $M = 20.90 \pm 0.643$ mm.; hooks in hamulus, M = 12.25 ± 0.479; flagellar segment 2/segment 1, M = 5.30 ± 0.174.

Structure and color: Integumental color as in *apicata* with the following differences: clypeus entirely yellow except black notches posteriorly at tentorial pits; labrum with small median yellow spot (holotype) or entirely black; mandible with (holotype) or without small basal pale spot. Structure as in *apicata* except as follows: clypeus with coarse round punctures separated from each other by half to one puncture width laterally and with a narrow longitudinal impunctate median area, ground areas shiny, unshagreened; minimum length of first flagellar segment equals ⅕ to ⅙ of maximum length of second segment; maxillary palpi as in female; galeae as in female; metasomal terga with ground areas dulled by fine dense transverse shagreening; pygidial plate broader than in *apicata* and less deeply notched laterally.

Genital capsule essentially as in *M. fimbriata* and *M. apicata;* penis valve with lateral process short and blunt as in *fimbriata.* Sternum 7 as in *apicata* but with median plates more distinctly necked, with more abundant hairs ventrally on median plates, with membranous area between plates much smaller and with apodemes longer and narrower (Fig. 7). Sternum 8 as in *apicata* but with apical margin truncate or slightly concave.

Hair: As in *apicata* except as follows: tegulae and humeral angles of wings with pale hairs; posterior lobes of pronotum without dark hairs; metasomal tergum 2 with apical white band narrowly interrupted medially; terga 2 and 3 with apical bands not reaching apical margins of terga in median thirds or less; inner surfaces of basitarsi and tibiae with yellow hairs.

Type material: Holotype male and allotype female from Levy County, Florida, April 13, 1955, on *Opuntia* sp., T. B. Mitchell, is in the collection of the North Carolina State College, Raleigh, North Carolina. Four female and three male paratypes are as follows: FLORIDA: Alachua Co., 1 ♀, April 27, 1955, on *Opuntia* sp., R. A. Morse; Lake Co., 1 ♂, April 20, 1922, T. P. Winter; Gainesville, 1 ♀, May 1, 1955, on *Opuntia* sp., R. A. Morse; Orange City, 1 ♀, April 22, 1928, C. O. Bare. GEORGIA: Wadley, 1 ♂, April 23, 1938, C. H. Curran. NORTH CAROLINA: Southern Pines, 2 ♀ ♀, May 20, 1953, on *Opuntia* sp., T. B. Mitchell; Wayne Co., 1 ♂, April 7, 1954, T. B. Mitchell. The paratypes will be deposited in the collections of the North Carolina State College, Raleigh, the Snow Entomological Museum, Lawrence, Kansas, the American Museum of Natural History, New York City, the University of Michigan, Ann Arbor, the State Plant Board of Florida, Gainesville, and in the author's collection.

Subgenus *Psilomelissodes* LaBerge

Psilomelissodes LaBerge, 1956, Univ. Kansas Sci. Bull., vol. 37, p. 1173.

Type species. Melissodes intorta Cresson, 1872, monotypical and by original designation.

This subgenus was erected to include a single species which is distinctive because of its sparse pubescence, the weak scopal hairs in the female, the short male antennae and the black male clypeus. A complete subgeneric description is given by LaBerge (1956).

Melissodes (Psilomelissodes) intorta Cresson

Melissodes intorta Cresson, 1872, Trans. Amer. Ent. Soc., vol. 4, p. 278; Birkmann, 1899, Ent. News, vol. 10, p. 245; Cockerell, 1902, Entomologist, vol. 35, p. 177; 1906, Trans. Amer. Ent. Soc., vol. 32, p. 75; Cresson, 1916, Mem. Amer. Ent. Soc., vol. 1, p. 121.

Melissodes wickhami Cockerell, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 112 (new synonymy).

Female: Measurements and ratios: N, 7; length, 11.0-12.0 mm.; width, 4.0-4.5 mm.; wing length, M = 24.10 ± 0.389; hooks in hamulus, M = 13.43 ± 0.298; flagellar segment 1/segment 2, M = 2.14 ± 0.082.

Structure and color: Integument black except as follows: mandible with apical half red or covered by a large median golden-yellow macula (in unworn condition); flagellar segments 2-10 dark reddish brown to brown below; eyes gray; tarsi and often remainder of legs brown; tegulae piceous, but often clear posteromedially; wing membranes infumate, brownish, veins brown to black; terga 1-4 with narrow colorless apical margins.

Clypeus with round, regular, small punctures separated mostly by less than one puncture width, with a short median carina near apex, ground areas shiny, unshagreened; supraclypeal area with deep round punctures, ground shiny; galeae sparsely punctate above, ground shiny, unshagreened; maxillary palpi 4-segmented, in ratio of about 6:5:3:1; flattened areas of vertex extending mesad from apices of compound eyes with small round punctures separated by one puncture width or less, ground shiny, unshagreened. Mesoscutum with deep round punctures relatively evenly spaced but slightly sparser posteromedially than anteriorly and laterally and becoming distinctly larger and more crowded in posterior declivity, ground areas somewhat dulled by exceedingly fine tessellation posteromedially, shiny elsewhere; scutellum with abundant crowded punctures similar to posterior declivity of mesoscutum, ground shiny; mesepisterna with large, round, deep punctures separated by half a puncture width or less, many confluent with neighbors, ground shiny; metanotum somewhat elevated medially, punctate in median third, impunctate or indistinctly punctate in lateral thirds, lateral areas dulled by fine tessellation; propodeum with dorsal surface irregularly rugose laterally, surface dulled by tessellation, with posterior surface sparsely punctate laterally, punctures becoming more abundant at extreme lateral margins, ground areas dulled by coarse tessellation, with lateral surfaces coarsely and densely punctate and tessellate. Metasomal tergum 1 with sparse, shallow, indistinct punctures scattered over basal 3/5 of dorsal surface, punctures separated by one puncture width at extreme base and extreme sides and by two puncture widths or more elsewhere, ground areas opaque, dulled by dense, coarse, reticulate shagreening; tergum 2 with interband zone irregularly and sparsely punctate, punctures of irregular size and separated by one to several puncture widths from nearest neighbors in any direction, with dense coarse punctures beneath distal pubescent band, apical area impunctate, ground areas opaque, dulled as in tergum 1; terga 3 and 4 similar to tergum 2 but interband zones with more abundant punctures; sterna coarsely punctate, ground areas dulled by fine tessellation.

Hair: On head white except abundant brown hairs on vertex between apices of compound eyes and ochraceous hairs on labrum and mandibles. Thorax with white hairs except large brown posteromedian mesoscutellar patch which extends forwards beyond a transverse line at anterior margins of tegulae and scutellar hairs brown except marginal white hairs. Metasomal tergum 1 with sparse white hairs basally and laterally on dorsal surface; tergum 2 with sparse basal band of white pubescence, narrow distal band of white pubescence which becomes thinner and is interrupted medially, basal and distal bands connected at extreme sides by white pubescence, apical and interband areas with sparse, white, short pubescence; tergum 3 similar to tergum 2 but with apical and interband areas with more abundant pale pubescence and with short, erect or suberect, spinelike, pale brown hairs present in interband zone; tergum 4 similar to tergum 3 but pale pubescence and spinelike hairs of interband zone more abundant and the latter longer and with distal pale band reaching apex of tergum although often with a bare median patch at apex; terga 5 and 6 with long, dark brown, appressed hairs. Sternal hairs dark brown.

Legs with hairs as follows: coxae, trochanters and femora white except brown at tips of femora; fore and middle tibiae with outer surfaces white basally and pale brown apically; outer surfaces of middle basitarsi pale brown; inner surfaces of fore tibiae and middle basitarsi, fore tarsi, middle and hind distitarsi brown; inner surfaces of hind basitarsi and tibiae reddish yellow to brownish red; scopal hairs ochraceous medially, brown surrounding and below basitibial plates and pale brown on apical halves of basitarsi. Scopal hairs weak, sparse, mostly with two or three long weak usually curved branches on either side of rachises and often with fewer branches, surface of tibiae is clearly visible through the weak hairs.

Male: Measurements and ratios: N, 20; length, 11.0-13.0 mm.; width, 3.0-4.0 mm.; wing length, M = 24.18 ± 0.339 mm.; hooks in hamulus, M = 12.65 ±0.335; flagellar segment 2/segment 1, M = 1.12 ± 0.001.

Structure and color: Color as in female except as follows: flagellar segments 2-11 yellow to red below; tergum 1 more broadly hyaline apically; tergum 5 hyaline apically; hyaline marginal zones of terga 1-5 usually yellow or translucent brown rather than colorless. Structure and sculpturing as in female with the following additions: minimum length of first flagellar segment equals maximum length of second segment or slightly less, usually about 6/7 of second segment (Fig. 13); tergum 1 with basal 3/5 or more punctate, punctures somewhat more abundant than in female, especially laterally and basally; interband zones of terga 2 and 3 more densely punctate; terga 4 and 5 similar to tergum 3; sternum 6 with prominent short oblique carinae near apex, broadly convex medially, truncate, with sparse punctures posterior to apical carinae, ground shiny, with sparse transverse shagreening.

Terminalia described and figured by LaBerge (1956, Figs. 122-125).

Hair: As in female with the following differences: vertex of head often without brown hairs; tergum 1 with long white hairs more abundant; tergum 2 with distal pale band often complete; interband zones of terga 2-4 with more abundant pale pubescence and more abundant spinelike hairs; terga 4 and 5 with distal pale bands as in tergum 3 but with sparse brown tomentum at extreme bases; terga 6 and 7 with dark brown hairs; sternal hairs pale at least lateroapically; legs with white hairs except red to yellow on inner surfaces of tarsi.

Bionomics: It is probable that this is an oligolectic bee dependent upon malvaceous plants of the genus *Callirhoe* for its pollen. However, only eight females are known and among these only two bear flower labels. These two specimens were collected by R. H. Beamer visiting flowers of *Gaillardia*. One of these has *Callirhoe* pollen in its scopae, whereas the other bears pollen from some other plant (it is not certain whether this is *Gaillardia* pollen or not). The males have been collected visiting *Callirhoe* flowers in several localities in Texas and Kansas.

Type material: The lectotype male of *intorta* is in the Academy of Natural Sciences, Philadelphia, Pennsylvania. The holotype female of *wickhami* is in the University of Colorado Natural History Museum, Boulder, Colorado.

Distribution: This species ranges from eastern Texas north to eastern Kansas. It has been collected from April 14 to June 27. In addition to the type material, 22 males and 7 females have been examined from the localities listed below.

KANSAS: Baxter Springs (5 miles E. and 5 miles S.); Brookville; Gove Co.; Manhattan; Riley Co.; Scott City (12 miles N.). TEXAS: Childress; Fedor, Lee Co.; Gillespie Co.; Giddings; Goliad (16 miles E.); Lee Co.; Stonewall; Sweet Home; Weser, Goliad Co.

Remarks: A single specimen labeled "Camd. Co., N. J., Collection W. J. Fox" is evidently mislabeled. I have found several specimens of other species of *Melissodes* of the W. J. Fox collection, ostensibly from Camden Co., New Jersey, which belong to western species and are obviously mislabeled.

Flower records: Asclepias latifolia, Callirhoe sp., *C. digitata, C. leiocarpa, Gaillardia* sp., *Rorippa sinuata.*

Subgenus *Heliomelissodes* LaBerge

Heliomelissodes LaBerge, 1956, Univ. Kansas Sci. Bull., vol. 37, p. 1172.

Type species. Melissodes desponsa Smith, 1854, by original designation.

This subgenus consists of two species widely distributed in North America. The subgenus can be distinguished by the protruding clypei and long galeae in both sexes and by the male antennae being of moderate length. A detailed description is given by LaBerge (1956). The subgenus is restricted to plants of the genus *Cirsium* (Compositae) or related genera for pollen sources.

KEY TO THE SPECIES OF THE SUBGENUS HELIOMELISSODES

Males

1. Metasoma with black pubescence and hairs on terga 2 to 7; mesoscutum with few or no black hairs posteromedially; legs with black hairs on outer surfaces of tibiae and tarsi .... *desponsa*

   Metasoma usually with some pale ochraceous to white pubecent bands or fasciae medially at least on tergum 2, often on terga 3 and 4 and occasionally on tergum 5 as well; legs usually with pale hairs on outer surfaces of tibia and often pale on tarsi as well ...... *rivalis*

Females

1. Metasoma without pale pubescent bands or fasciae on terga 2 to 4; mesoscutum without posteromedian patch of dark hairs or this patch smaller than dark scutellar patch; mesoscutum with punctures posteromedially mostly separated by one puncture width or less .... *desponsa*

   Metasoma usually with pale pubescent bands or fasciae at least on tergum 2 and often on terga 3 and 4 as well, *if* without pale pubescence, *then* mesoscutum with posteromedian patch of dark hairs larger than dark scutellar patch; mesoscutum usually with a posteromedian area of sparse punctures separated mostly by two puncture widths or more ...... *rivalis*

Melissodes (Heliomelissodes) desponsa Smith

Melissodes desponsa Smith, 1854, Cat. Hymen. British Museum, Part II. Apidae, p. 310; Cresson, 1879, Trans. Amer. Ent. Soc., vol. 7, p. 225; Provancher, 1882, Le Naturaliste Canadien, vol. 13, p. 174; Robertson, 1894, Trans. Acad. Sci. St. Louis, vol. 6, pp. 455, 459, 470, 473, 475; 1897, Trans. Acad. Sci. St. Louis, vol. 7, p. 354; 1901, Canad. Ent., vol. 33, p. 230; Viereck, *et al.*, 1905, Canad. Ent., vol. 37, p. 320; Lovell and Cockerell, 1906, Psyche, vol. 13, p. 109; Cockerell, 1906, Trans. Amer. Ent. Soc., vol. 32, pp. 76, 83; Smith, 1910, Ann. Rept. New Jersey State Museum, 1909, p. 693; Viereck, 1916, Bull. Connecticut State Geol. and N. H. Surv., vol. 22, p. 732; Criddle, Curran, Viereck and Buckell, 1924, Rept. Ent. Soc. Ontario, vol. 33, p. 99; Leonard, 1926, Cornell Univ. Agric. Exp. Sta. Mem., No. 101, p. 1028; Graenicher, 1935, Ann. Ent. Soc. Amer., vol. 28, p. 304.

Melissodes daponsa (*sic*) Bridwell, 1899, Trans. Kansas Acad. Sci., vol. 16, p. 211.

Melissodes nigripes Smith, 1854, Cat. Hymen. British Museum, Part II. Apidae, p. 311 (♂, *nec* ♀); Cresson, 1879, Trans. Amer. Ent. Soc., vol. 7, p. 225; Provancher, 1888, Addit. Faun. Can., Hymen., vol. 2, p. 300; Smith, 1896, Rept. Ent. Dept. New Jersey Agric. Coll. Exp. Stat., fig. 21; Robertson, 1900, Trans. Acad. Sci. St. Louis, vol. 10, p. 53; 1901, Canad. Ent., vol. 33, p. 230; Cockerell, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 102; Smith, 1910, Ann. Rept. New Jersey State Museum, 1909, p. 693.

Melissodes cnici Robertson, 1901, Canad. Ent., vol. 33, p. 230; Cresson, 1879, Trans. Amer. Ent. Soc., vol. 7, p. 225; Robertson, 1905, Trans. Amer. Ent. Soc., vol. 31, p. 369; Cockerell, 1905, Canad. Ent., vol. 37, p. 312; 1906, Trans. Amer. Ent. Soc., vol. 32, pp. 77, 83, 89; Graenicher, 1911, Bull. Publ. Mus. Milwaukee, vol. 1, p. 247; Gileson, 1914, Forty-fourth Ann. Rept. Ent. Soc. Ontario, 1913, p. 125; Robertson, 1914, Ent. News, vol. 25, p. 69; 1926, Ecology, vol. 7, p. 379; 1928, Flowers and Insects, p. 8; Pearson, 1933, Ecol. Monogr., vol. 3, p. 381.

The status of the various names which have been applied to this bee has been confusing. Cresson in 1879 first synoymized *M.*

nigripes Smith with *M. desponsa* Smith. He was followed in this by Dalla Torre (1895). Robertson in 1901 named this species *M. cnici.* Lutz and Cockerell (1920) recognized that *M. cnici* Robertson was a new name for the male (but not the female) of *M. nigripes* Smith and stated that *M. cnici* might include the female of *desponsa.*

Dr. I. H. H. Yarrow of the British Museum (Natural History) has kindly examined specimens of *M. cnici* sent to him and assures me in a letter dated August 4, 1954, that the female type of *M. desponsa* Smith and the male cotype of *M. nigripes* Smith are both conspecific with the specimens of *M. cnici.* I, therefore, concur with the opinion expressed by Lutz and Cockerell (1920) that the names *nigripes* and *cnici* should be regarded as synonyms of *desponsa.* The female cotype of *M. nigripes* Smith is, unfortunately, a *Tetralonia,* according to Dr. Yarrow. In addition to this male and female of *nigripes* in the British Museum, Dr. Yarrow has brought to light two males labeled *nigripes* Sm. by Smith himself. One of these is from Mt. Pleasant (R. Forster) and is undoubtedly *cnici* Robertson, but the second which is from the United States has a very swollen clypeus and is probably an *Emphor.* Dr. Yarrow (in a letter dated November 23, 1955) agrees that the male of *nigripes* which was in the British Museum before Dr. Yarrow found the additional two males should be designated as the lectotype. This, in effect, retains the name *nigripes* Smith in the genus *Melissodes* as a synonym of *M. desponsa* Smith.

This species is distinctive because of the black metasoma and the pale upper surface of the mesosoma. It converges in this coloration with a race of the closely related *M. rivalis* Cresson occurring in the Pacific Northwest. However, it can be distinguished from these darker specimens of *rivalis* by the lack of a patch of dark hairs posteromedially on the mesoscutum, or this patch is small and no larger than that on the scutellum. Minor differences in punctation and structure also separate the two species and these are described below.

Female: Measurements and ratios: N, 20; length, 11.5-16.0 mm.; width, 4.0-5.5 mm.; wing length, $M = 25.21 \pm 0.157$ mm.; hooks in hamulus, $M = 14.00 \pm 0.229$; flagellar segment 1/segment 2, $M = 2.03 \pm 0.020$.

Structure and color: Integument black except as follows: flagellar segments 2-10 dark reddish brown below; apical half of mandible red with broad golden macula apically; apical margin of clypeus often reddish; eyes grayish blue to green; distitarsi dark red; wing membranes infumate, brownish; tegulae piceous; tibial spurs piceous.

Clypeus with small crowded punctures separated by less than one puncture width, without a distinct median carina, ground areas dulled by coarse transverse shagreening, moderately shiny; supraclypeal area with coarse round punctures, ground areas dulled by coarse, reticular shagreening; vertex with flattened area extending posteromesad of apex of compound eye with small, deep, round punctures separated by less than half to two puncture widths, ground areas shiny to moderately so, with fine shagreening; maxillary palpal segments in ratio of about 3.5:2.5:2.5:1, the last segment often much shorter; galea shiny above with small sparse scattered punctures bearing short straight hairs, shagreened near tip and laterally. Mesonotum coarsely punctate, punctures separated by less than half a puncture width anteriorly and peripherally, by slightly more posteromedially just before posterior declivity, slightly larger posteromedially than anteriorly, ground areas slightly dulled by fine reticular shagreening; scutellum coarsely punctate, similar to mesoscutal sculpturing but shagreening finer or absent; metanotum with scattered punctures, ground dulled by tessellation; propodeum with dorsal surface reticulorugose basally, coarsely punctate apically, with posterior surface coarsely punctate except on upper impunctate median triangle, with lateral surfaces coarsely punctate, with ground areas opaque, dulled by coarse, dense tessellation; mesepisterna with lateral surface with large shallow punctures separated by less than half a puncture width, some confluent medially, becoming smaller and more distinct dorsally and posteriorly, ground areas somewhat dulled by irregular shagreening. Metasomal tergum 1 with a line of close-set punctures just beyond middle, these separated by a slight gap in median ⅘ of tergum from basal area with abundant small round shallow punctures, ground areas dulled; tergum 2 with minute, round deep punctures at extreme base, with interband zone relatively impunctate medially and with small crowded punctures laterally, apical zone with minute, sparse punctures laterobasally, ground areas dulled; terga 3 and 4 similar to tergum 2 but with punctures smaller and more abundant in interband and apical zones.

Hair: Generally shorter and more abundant on mesosoma, shorter on prosoma and less abundant on metasoma than in *M. mysops.* Head with black to dark brown hairs on clypeus, genal areas, mandibles and often an occiput behind vertex, with hairs of face and vertex all pale ochraceous or ochraceous and brown mixed. Metasoma with pale ochraceous hairs except as follows: mesoscutum with posteromedian patch of dark brown to black hairs often present but never extending forward to a transverse line at middle of tegulae and scarsely, if at all, any larger than that on scutellum; scutellum with dark brown to black hairs medially; lateral surfaces of mesepisterna with dark hairs on lower half or more; metepisterna and lateral surfaces of propodeum with dark brown to black hairs. Mesosoma with dark brown to black hairs except as follows: white to pale ochraceous on basal $3/5$ of dorsal surface of tergum 1 (often mixed with dark hairs), tergum 2 with basal band often consisting of at least partially pale pubescence. Legs with dark brown to black hairs except scopal hairs which are yellow to ochraceous and hairs of inner surfaces of hind tibiae which are red to yellow.

Male. Measurements and ratios: N, 20; length, 9.0-14.0 mm.; width, 2.5-4.5 mm.; wing length, M = 23.79 ± 0.280 mm.; hooks in hamulus, M = 13.00 ± 0.218; flagellar segment 2/segment 1, M = 2.93 ± 0.059.

Structure and color: Integument black except as follows: clypeus pale yellow except reddish brown apical margin and black notches marking tentorial pits, in specimens from eastern parts of the range often infuscated in posterior angles from tentorial pits to posterior margin in middle of clypeus; flagellar segments 2-11 yellow to red below; eyes green to gray; distitarsi, sterna and often apices of terga dark reddish brown; wing membranes somewhat infumate, brownish; tegulae and tibial spurs piceous.

Minimum length of first flagellar segment at least as long as one third of maximum length of second segment and usually longer. Maxillary galeae, palpae and sculpturing of head and body as in female with the following differences: clypeal punctures smaller and denser; lateral areas of vertex often with ground dulled by shagreening; first metasomal tergum punctate in basal $4/5$ of dorsal surface medially and to the apex in lateral thirds, punctures small and shallow; tergum 2 with interband zone with punctures small, indistinct but scarsely any sparser than interband zone of terga 3 and 4; last exposed sternum with truncate apical margin, with strong lateral oblique carinae near apex, with short median depression in apical half between and posterior to apices of oblique carinae, shiny and unshagreened but with small deep punctures basally.

Terminalia as described and figured by LaBerge (1956, Figs. 114-117). Spatha of genital capsule feebly emarginate medially on apical margin. Sternum 7 with few short hairs apically, narrower in middle than at anterior third. Sternum 8 with apodemes truncate and slightly capitate.

Hair: Color generally as in the female but usually with more abundant pale hairs on head and sides of thorax and hairs of hind legs all dark brown to black except on inner surfaces of hind tarsi.

Bionomics: Nothing has been reported concerning the nesting sites or nest architecture of *M. desponsa.* This bee is oligolectic and prefers flowers of the genus *Cirsium* as pollen sources, although it has been collected occasionally on other genera of Composites and also on flowers of other families. A total of 263 of the specimens studied by the author bear flower labels. The data from these specimens are summarized in Table 1. Additional flower records available in the literature are not included in this table, since no quantitative data were available. The table clearly demonstrates the preference of *desponsa* for flowers of the genus *Cirsium.*

TABLE 1

Family	Plant data		*M. desponsa* data			
	Number of genera	Number of spp.	Number of colls.	Number of ♀♀	Number of ♂♂	Total number of bees
Compositae, other than *Cirsium*	7	9	11	6	8	14
Compositae, *Cirsium* spp.	1	8	64	126	118	244
Labiatae	1	1	1	1	0	1
Leguminosae	1	1	1	0	1	1
Verbenaceae	1	2	2	0	3	3
Totals	11	21	79	133	130	263

Type material: Female holotype of *desponsa* from Ohio is in the British Museum (Natural History) (17B855). Male lectotype of *nigripes,* here designated, from the United States is in the British Museum (Natural History) (17B836). Lectotype male and lecto-allotype female of *cnici,* here designated, from Carlinville, Illinois, August 18, 1897, on *Cnicus lanceolatus,* Charles Robertson collector, are in the collection of the Illinois Natural History Survey, Urbana, Illinois.

Distribution: This species ranges from Nova Scotia in the northeast, to North Carolina in the southeast, to Alabama in the south and to Oklahoma and eastern North Dakota in the west. One specimen labeled Laramie, Wyoming, was seen by the author. This label is of doubtful validity. It has been collected from June 26 to October 16, but mainly in August. In addition to the type material, 474 females and 344 males have been examined from the localities listed below. This list includes localities reported in the literature.

ALABAMA: Kushla. CONNECTICUT: Canaan City; Chappinville; Colebrook; Greenwich. ILLINOIS: Attwood; Bath; Beverly Hills; Bluffs; Carlinville; Champagne; Charleston; Chicago; Downers Grove; Kankakee; Matteson; McHenry; Olive Branch; Pittsfield; Urbana; Willow Springs. INDIANA: Allen Co.; Lafayette; Warren Co.; White Co. IOWA: Ames; Dickinson Co.; Iowa City; Lake Okoboji; Ledges State Park; Mt. Pleasant; Nevada; Sioux City. KANSAS: Baldwin; Delavan, Morris Co.; De Soto, Johnson Co.; Douglas Co.; Iola; Kansas City; Lawrence; Manhattan; McPherson Co.; Norton, Riley Co.; Olathe; Riley Co.; St. George; Sunflower; Topeka; Wildcat. MAINE: Waldoboro; Winthrop. MARYLAND: Bethesda; Cabin John; Glen Echo; Millington. MASSACHUSETTS: Holden; Lexington; Lowell, Montossy; Needham; Wollaston; Woods Hole. MICHIGAN: Alger Co.; Ann Arbor; Cheboygan; East Lansing; Grand Rapids; Ingham Co.; Midland; Millington; Otsego Co.; Pontiac; Tuscola Co. MINNESOTA: Alex; Dakota Co.; Eitzen; Erskine; Excelsior; Faribault Co.; Frazer; Freeborn Co.; Grand Meadow; Hastings; Hayward; Hennepin Co.; Jordan; Lake Park; Olmsted Co.; Ramsay Co.; Rochester; Rock Co.; Spring Valley; Stanton; St. Anthony Park; St. Cloud; St. Paul; Warren; Washington Co.; Zumbra Heights, Carver Co. MISSOURI: Columbia; Hannibal; Sedalia; Smithton; St. Louis. NEBRASKA: Fullerton; Gordon, Sheridan Co.; Lincoln; Long Pine; Malcolm; Nebraska City; Neligh; Omaha; Roca; West Point. NEW HAMPSHIRE: Alstead; Durham; Pelham. NEW JERSEY: Arlington; Englewood; Kearny; New Brunswick; Princeton. NEW YORK: Brooklyn; Calicoon; Fishers Island; Flatbush; Fort Wadsworth; Huguenot; Ithaca; Long Island; New Baltimore; Staten Island; Stockport; Van Cortland Park, New York City; Westville. NORTH CAROLINA: Black Mts. (valley of); Bryson

City; Doughton Park. NORTH DAKOTA: Fargo; Henkinson; Oakes. OHIO: Columbia; Ironton; Logan Co. OKLAHOMA: Umatilla. PENNSYLVANIA: Carlisle; Philadelphia; Pike Co. RHODE ISLAND: Scituate. SOUTH DAKOTA: Brookings; Vermillion; Yankton. VERMONT: Chittenden (Rutland); Hartland; Woodstock. VIRGINIA: Alexander Island; Falls Church; Vienna (2 and 3 miles W.). WEST VIRGINIA: Canaan Valley. WISCONSIN: Farmington; Hudson; Madison; Maiden Rock, Pierce Co.; Milwaukee; Nevers Dam, Polk Co.; Prescott; Randall, Burnett Co.; Shullsburg, Lafayette Co.; Washington Co.; Worden Township, Clark Co. WYOMING: Laramie (questionable). NEW BRUNSWICK: Grand Manan Island. NOVA SCOTIA: Weymouth. ONTARIO: Carp (5 miles W.); Marmora; Ottawa; Toronto; West Hill. QUEBEC: Cap Rouge; Fort Coulogne; Lowe; Montreal; Quebec City; Ste. Annes; St. Fargeau.

Flower records: Aster novaeangliae, Brauneria purpurea, Carduus crispus, Cassia sp., *Centaurea* sp., *C. jacea, Cirsium* sp., *C. altissimum, C. arvense, C. discolor, C. hilii, C. odoratus, C. pumilum, C. undulatum, C. vulgare, Coreopsis aristosa, Helianthus annuus, H. grosseserratus, Inula helenium, Monarda fistulosa, Pontederia cordata, Pycnanethemum* sp., *Rudbeckia laciniata, Silphium perfoliatum, Solidago* sp., *S. canadensis, S. puberula, Verbena* sp., *V. stricta.*

Melissodes (Heliomelissodes) rivalis Cresson

Melissodes rivalis Cresson, 1872, Trans. Amer. Ent. Soc., vol. 4, p. 277; Cockerell, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 76; Cresson, 1916, Mem. Amer. Ent. Soc., vol. 1, p. 129.

Melissodes desponsiformis Cockerell, 1905, in Viereck *et al.*, Canadian Ent., vol. 37, p. 320 (new synonymy); 1906, Trans. Amer. Ent. Soc., vol. 32, p. 89.

Melissodes mysops Cockerell, 1905, Entomologist, vol. 38, p. 146 (new synonymy);1905, Canadian Ent., vol. 37, p. 321; 1906, Trans. Amer. Ent. Soc., vol. 32, pp. 88, 89, 113; 1907, Entomologist, vol. 40, p. 269; 1910, Ann. Mag. Nat. Hist., ser. 8, vol. 6, p. 128; 1910, Univ. Colorado Studies, vol. 7, p. 128; Criddle, Curran, Viereck and Buckell, 1924, Fifty-fourth Ann. Rept. Ent. Soc. Ontario, p. 99; Scullen, 1928, Pan-Pac. Ent., vol. 4, p. 176; Bohart, Knowlton and Bailey, 1950, Utah State Agric. Coll., mimeo. series no. 371, p. 5.

Melissodes hexacantha Cockerell, 1905, Psyche, vol. 12, p. 100 (new synonymy); 1906, Trans. Amer. Ent. Soc., vol. 32, p. 75; Snow, 1906, Kansas Acad. Sci., vol. 20, p. 137; Bohart, Knowlton and Bailey, 1950, Utah State Agric. Coll., mimeo. series no. 371, p. 5.

Melissodes nigrosignata Cockerell, 1905, Psyche, vol. 12, p. 101 (new synonymy); 1906, Trans. Amer. Ent. Soc., vol. 32, pp. 88, 109, 309; Snow, 1906, Trans. Kansas Acad. Sci., vol. 20, p. 137.

Melissodes habilis Cockerell, 1925, Ann. Mag. Nat. Hist., series 9, vol. 16, p. 229 (new synonymy); 1928, Univ. Colorado Studies, vol. 16, p. 114; 1937, Amer. Mus. Nov., no. 899, p. 5.

This is a highly variable species. No subspecies will be recognized in this paper for reasons expounded below. The males of *rivalis* are distinguished by the pale pubescent bands on terga 2 and 3 and often on 4 and 5 as well, and by the posterior edge of the clypeus usually being darkened. The females of *rivalis* can usually be recognized by having pale pubescent bands on terga 3, 2 or 4, in that order, or at least having lateral fasciae of white pubescence on one of these terga, or, if without pale pubescence on any metasomal tergum, by having a large patch of black hairs on the mesoscutum which exceeds the size of the dark scutellar patch.

Female: Measurements and ratios: N, 20; length, 12.0-17.0 mm.; width, 4.5-6.0 mm.; wing length, M = 25.14 ± 0.339 mm.; hooks in hamulus, M = 15.25 ± 0.376; flagellar segment 1/segment 2, M = 2.03 ± 0.036.

Structure and color: As in *M. desponsa* with the following differences: eyes usually grayish blue; wings infumate brown; apical margin of clypeus black; clypeus with irregular crowded punctures, with a distinct median longitudinal carina in apical half or less; mesoscutum usually with posteromedian area with sparse punctures separated mostly by two puncture widths or more.

Hair: Darkest specimens as in dark specimens of *M. desponsa* with the following differences: mesonotum with large patch of dark brown to black hairs which extends forward to or beyond a transverse line at anterior margins of tegulae; mesepisterna with dark brown hairs at least on lower two thirds; posterior pronotal lobes and tegulae with dark hairs; metasomal tergum 1 with long dark brown hairs basally; inner surfaces of hind basitarsi and tibiae with dark red to black hairs. Palest specimens with head hairs white or grayish white except some brown hairs on vertex, with mesepisternal and pronotal hairs white or pale ochraceous, with dark mesonotal patch extending forward to a transverse line at least at middle of tegulae; metasomal tergum 1 with long pale hairs basally, tergum 2 with basal band of white pubescence and distal band of pale ochraceous pubescence (the latter narrowed and often interrupted medially, separated from apical margin of tergum), tergum 3 with distal pale pubescent band, tergum 4 with apical pale pubescent band, tergum 5 with small lateral tufts of white hairs; sterna 2 to 4 with pale hairs apicolaterally, red to brown hairs medially; inner surfaces of hind basitarsi and tibiae and fore and middle basitarsi with hairs red to reddish brown. All intergrades occur between these two extremes of vestiture coloration. The tergal pale hairs appear in the following order: (1) base of tergum 1 and basally on tergum 2, (2) lateral fasciae on tergum 2, (3) lateral fasciae on tergum 3, (4) lateral fasciae on tergum 4, (5) lateral tufts on tergum 5. The lateral fasciae become progressively wider in paler specimens forming complete pubescent bands in the same order of appearance.

Male: Measurements and ratios: N, 20; length, 11.0-16.5 mm.; width, 4.0-5.0 mm.; wing length, M = 23.94 ± 0.088 mm.; hooks in hamulus, M = 13.85 ± 0.318; flagellar segment 2/segment 1, M = 2.88 ± 0.062.

Structure and color: As in *M. desponsa* with the following differences: rarely with basal mandibular yellow spot and with small median labial pale spot (in less than 2 per cent of specimens); clypeus with posterior margin darkened at least in lateral angles mesad of tentorial pits, often with posterior third to half black and rarely more, never entirely black, usually posterior margin of yellow clypeal area produced posteriorly in median third; sculpturing as in female.

Terminalia essentially as in *M. desponsa* but with fewer hairs on gonostyli and sternum 7 with slightly smaller membranous areas between median and lateral plates and with broader, less capitate apodemes (Figs. 8-11).

Hair: Darkest specimens as follows: head hairs white to pale ochraceous except brown on vertex; scutellum with abundant dark brown hairs medially, mesoscutum with posteromedian patch of dark brown hairs extending forward to or beyond a transverse line at middle of tegulae, other mesosomal hairs white to ochraceous; metasomal tergum 1 with long pale hairs basally, short dark hairs apically, tergum 2 with complete distal pale pubescent band separated from apical margin of tergum and narrowed medially and with basal pale pubescent band, tergum 3 with distal pale pubescent band interrupted medially by brown hairs, terga 4-7 without pale hairs, legs with pale hairs at least on outer surfaces of middle and hind tibiae, inner surfaces of hind tibiae and fore, middle and hind basitarsi with hairs red to reddish brown. Palest specimens similar but with the following differences: without dark hairs on head, mesoscutum or scutellum, with complete pale pubescent bands on terga 2, 3, 4 and 5 and lateral tufts of long pale hairs on tergum 6, with sternal hairs red medially and pale ochraceous laterally on sterna 2 to 5, brown on sternum 6, legs with white to ochraceous hairs except pale brown on outer surfaces of fore tarsi and tibiae, red on inner surfaces of fore middle and hind basitarsi and hind tibiae. As in the females, all intergrades occur between these two extremes in vestiture coloration. Progressively, from darkest to palest, pale hairs appear in the following order: (1) lateral fasciae of pale pubescence on tergum 4 and then on tergum 5 as the interrupted band of tergum 3 closes medially, (2) lateral fasciae of pale pubescence on tergum 4 closes in medially to form a complete band and those on tergum 5 close in as the head and thoracic hairs become pale, (3) scutellum is the last area to retain brown hairs.

Bionomics: The nesting of *M. rivalis* has been described by Scullen (1928) (*M. mysops*). Scullen discovered a group of about sixty individual nests scattered for a distance of about twenty feet in a sand bank along the summit of a sea cliff in the Coos Bay region on the Oregon coast. Both males and females were collected on nearby thistles (*Cirsium* sp.). Two nests were opened on July 2, 1926, and were found to contain pollen but no eggs. On July 13 nests were again opened and half-grown larvae and eggs were found. On July 21 seemingly full-grown larvae were present.

Scullen did not describe the nest architecture in his brief note and has kindly forwarded his field notes so that the nests can be more thoroughly described at this time. The following quotation is taken from a copy of field notes made by H. A. Scullen on July 13, 1926.

"Nests opened up show two to four branches leading off from each main gallery. Branches leading in various directions. Leave main gallery every one to two inches. Branches one to two inches long, crooked. A mass of pollen apparently moistened with honey at the bottom with one long egg on top. Pollen looked like thistle pollen. No cover over pollen. Side gallery not apparently closed unless by loose soil. Wall of gallery smooth and shiny as though coated with a secretion but no noticeable layer of special deposit.

"Egg in one cell apparently suspended by a series of web like threads attached to roof of cell. The egg was in contact with the honey-pollen mass but was readily lifted by grasping the mass of webbing. The webbing may have been for preventing the egg sinking in the semiliquid mass of food material. The web might have been threads of mould as three other masses of pollen were found badly moulded."

This account is interesting for at least two reasons. First, this is the third species which has definitely been reported in the literature as having been found nesting in a large group (see *M. obliqua* and *M. tepida* in LaBerge, 1956). However, one of the latter (*M. obliqua*) is also known to nest singly. Perhaps species of

Melissodes nest in groups only where certain areas with a favorable substrate are found to coincide with a large population of bees, concentrated, perhaps, by the nearby occurrence of favorable or preferred host plants.

Secondly, the webbing by which the egg in one cell was suspended from the roof of the cell is of interest. The present writer is inclined to the second opinion expressed by Scullen, that is, that the webbing was probably threads of mould.

The bees of this species are oligolectic. They, just as *M. desponsa*, seemingly are dependent upon composites of the tribe Cynareae and, particularly, upon plants of the genus *Cirsium*. Table 2 summarizes the plant-host data taken from labels of 201 specimens representing at least 74 collections.

TABLE 2

Family	Plant data		*M. rivalis* data			
	Number of genera	Number of species	Number of colls.	Number of ♀♀	Number of ♂♂	Total number of bees
Compositae, other than *Cirsium*.....	6	6	6	8	3	11
Compositae, *Cirsium* sp.......	1	5	58	71	100	171
Labiatae...........	2	3	5	4	4	8
Other (4)...........	4	4	5	1	10	11
Totals........	13	18	74	84	117	201

Geographical variation: As has been stated above, and as can be deduced from the description given above, *M. rivalis* is highly variable. A number of characters (4 male and 3 female) have been examined with the viewpoint of describing significant geographical variation. However, a statistical method for handling these data has not yet been settled upon. The variation will, therefore, be described below omitting such variation which is not obviously significant.

The vestiture of both females and males varies greatly in color. The darkest specimens occur in the humid coastal area of California and Oregon. The females from this area can be readily recognized and have been described as a species (*M. desponsiformis* Cockerell). The males, however, are not much darker than specimens from inland California, Oregon, Washington and British Columbia and a majority of the males from the coastal area cannot be distinguished from most of the males from the inland areas. A cline apparently exists from the darkest specimens of the coastal areas to the paler specimens of the more inland areas and no apparent step occurs in this cline. Perhaps with many more specimens taken in series from a number of localities in the critical areas of Oregon and Washington, a stepped cline might be shown to exist.

The palest specimens occur in Kansas, Texas and New Mexico. These specimens seem to be quite distinct from the specimens from the Rocky Mountain regions. However, so few specimens are known from this large prairie area, that definite conclusions are unwarranted. Specimens from northern Arizona show an unusual condition in that the females are as pale as the eastern prairie specimens, whereas the males are as dark as, and undistinguishable from, the northern Rocky Mountain specimens. A large gap exists between the specimens collected in New Mexico, Texas and Kansas and those collected in Arizona, Utah or Colorado. It is impossible to see whether smooth or stepped clines occur between the pale and the darker populations. Specimens from the northern prairie region of North Dakota, Minnesota, Saskatchewan and Manitoba are indistinguishable from the Rocky Mountain specimens. Very few specimens are known from South Dakota and Nebraska and nothing can be determined about the cline in color that probably exists between the southern and the northern prairie populations.

In general, specimens from the region from the middle of Oregon east to Minnesota, north to southern British Columbia and south to Colorado and Utah are intermediate in color between the California and Oregon coastal populations and the populations from the southern prairies. However, each population examined exhibits differences in the average darkness of the vestiture from adjacent populations. The bees from this large region have been called *M. mysops* Cockerell in the past.

The coloration of the male clypeus also varies greatly. To study this character, the median length of the posterior dark area was measured. It was found that specimens with the greatest amount of posterior infuscation of the clypeus occur in northern Arizona and southeastern Utah. The populations with the palest clypei, on the other hand, were collected in New Mexico, Texas, Kansas and eastern North Dakota. Specimens from western North Dakota and southern Manitoba, eastern Wyoming and northeastern Colorado, central and southern Colorado and northern Utah had the next palest clypei. Other than the Arizona populations, those with the darkest clypei were from Oregon and northern California. Two marked exceptions occurred from this general distribution of the clypeal coloration of males. First, the northern coastal Californian specimens and, second, the southern Idaho specimens exhibited very pale clypei. In general, there appears to be a cline in the amount of infuscation of the posterior part of the clypei of males from the darkest in the northwestern to palest in the southeastern and northeastern parts of the range of *M. rivalis.* Three exceptional areas occurred: an area with dark clypei in Arizona and Utah and the two above mentioned areas with pale clypei in California and Idaho. No steps, other than the above mentioned irregularities were observed in this cline.

The specimens also varied greatly in size. Two measurements were made on both males and females to represent size. The median length of the clypeus and the wing length were measured (see section on Descriptive Methodology in LaBerge, 1956, for method of measuring). These two measurements were highly correlated in each of the two sexes and, therefore, only one, that of wing length, is discussed below.

The distribution of wing length means for the two sexes was not highly correlated so they will be discussed separately. In the males, specimens with the shortest wings occurred in the coastal areas of Oregon and northern California. There seems to be an even cline in increasing male wing length toward the northeast—specimens with longest wings occurring in north central Washington (state). The male wings decrease again in length towards the north (British Columbia), the east (North Dakota and Manitoba) and the southwest (Utah, Colorado and Arizona), but nowhere average as short as in the coastal areas of northern California and southern Oregon. The wings increase in length in New Mexico and Kansas and again decrease in Texas, although the last decrease is, perhaps, not significant. The clines described in this paragraph do not correlate well with the clines described for color of vestiture or color of male clypeus.

The female wing length follows the same clines as the male with the following differences. In the females there appears to be a sharp step in the cline of increasing wing length from the coastal areas of northern California and southern Oregon towards the northeast. The shortest winged specimens occur in northwestern Oregon and southwestern Washington, whereas populations from southern British Columbia, central Washington, eastern Oregon, eastern Washington, Idaho and western Montana have mean wing lengths considerably longer. The long-winged specimens from New Mexico and Kansas contrast more strongly in the females than in the males with populations in Texas, Colorado, Arizona and New Mexico.

From the above discussion it can be seen that clines of at least three characters are not highly concordant. On the other hand, clines of any two characters examined can be seen to be concordant in at least some parts of the range of the species. No subspecies are recognized here and it seems unlikely that any should be recognized in the future due to the discordant nature of the clines and the inherent difficulties in recognizing the limits of any of the races. Perhaps when longer series of specimens from critical areas become available for a more thorough statistical analysis, subspecies (for which names already exist) will be recognized.

Type material: Lectotype male of *rivalis* from Texas is in the Academy of Sciences of Philadelphia. The female type of *desponsiformis* from Corvallis, Oregon, has not been located by the author. It is presumably lost or destroyed. The lectoallotype male, here designated, of *mysops* from Maybell, Colorado, August 1, 1904, is in the University of Colorado Museum, Boulder, Colorado, and the lectoallotype female, here designated, with the same data, is the property of the California Academy of Science, but is on temporary deposit in the collection of the Citrus Experiment Station, Riverside, California. The holotype male of *hexacantha* from Arizona, August, 1902, F. H. Snow, and the holotype female of *nigrosignata* from Oak Creek Canyon, Arizona, 6000 feet, August, F. H. Snow, are in the Snow Entomological Museum at the University of Kansas, Lawrence. The holotype male of *habilis* from Colorado Springs, Colorado, 6000-7000 feet, July 20-26, 1896, H. F. Wickham is in the American Museum of Natural History, New York City.

Distribution: M. rivalis ranges from northern California north to southern British Columbia, east to southern Manitoba and northwestern Minnesota, south to south central Texas, central New Mexico and central Arizona. It has been collected from May 14 to the beginning of October but most abundantly in July and August. In addition to the type material, 291 females and 375 males have been examined from the localities listed below. This list includes localities reported in the literature.

ARIZONA: Flagstaff; Grand Canyon; Houserock Canyon; Kaibab Forest; Oak Creek Canyon; Phoenix. CALIFORNIA: Camass Swamp, Glen Blair Road, Mendocino Co.; Carrville; Callahan; Crescent City; Dyerville; Fairfax; Fort Ross; Guerneville; Kneeland Prairie, Humboldt Co.; Lagunitas; Myers; Point Pinos, Monterey Co.; Salinero; Shasta Springs; Van Duzen River, Humboldt Co. IDAHO: Burley; Deary; Gifford; Hazelton (4 mi. N.); Idaho Falls; Lewiston; Moscow; Paris; Shoshone; Twin Falls. KANSAS: Dickinson Co.; Ellis Co.; Meade Co.; Ness Co.; Pratt Co.; Rice Co.; Russell Co. MINNESOTA: Marshall Co. MONTANA: Como Lake; Flathead Lake; Hot Springs, Sanders Co.; Missoula; Monterey; Whitehall. NEVADA: White Pass, White Pine Co. NEW MEXICO: Alto; Nogal; Roswell; Vaughn. NORTH DAKOTA: Beach; Bismarck; Dickinson; Fargo; Kenmare; Minot; New Rockford; Oakes; Sentinel Butte, Golden Valley Co.; Slope Co. (Logging Camp Ranch); Stanley; Williston. OREGON: Amity; Albany; Baker; Bellfountain; Bend; Canyon City; Cove; Grand Ronde; Grand Ronde River (N. of Imbler); Gold Beach; Griffin Creek, Jackson Co.; Heppner Junction, Gilliam Co.; Hood River, Hood River Co.; Hurricane Creek (Wallowa Canyon), Wallowa Co.; La Grande, Lake Appelgate, Jackson Co.; Lostine; Medford; Murphy; Oakridge; Oregon City; Prineville; Redmund; Richland; Roseburg; Siskiyou Summit, Jackson Co.; Summit Prairie; The Dalles; Thomas; Three-sisters (Lake Creek Lodge), Deschute Co.; Umatilla; Union; Wallowa Canyon, Wallowa Co.; Wilderville. SOUTH DAKOTA: Faulkton; Whitewood. TEXAS: Austin; Dallas; Eastland Co.; Hillsboro; Weser. UTAH: Big Cottonwood Canyon (near Salt Lake City); Brigham; Cache Valley (Beven Dam), Cache Co.; Clear Creek Canyon, Sevier Co.; Cottonwood Canyon; Echo; Fillmore; Fort Douglas; Helper; Huntsville; Hyde Park; Laketown; Logan; Logan Canyon; Manilla; Monticello; Parly's Canyon (E. of Salt Lake City); Salt Lake City; South Cove Fort, Millard Co.; South Willow Canyon, Stansbury Mts., Tooele Co.; Thistle; Tintic; Uintah Mts., Duchesne Co.; Vivian Park; Wasatch Mts., Tooele Co.; Wellesville; White Sands. WASHINGTON: Asotin (on Snake River); Blue Mts.; Govan; Liberty; Lind; Packwood; Pullman; Ritzville; Tucannon Canyon, Garfield Co.; Yakima. WYOMING: Bridger Basin, Teton Co.; Carbon Co.; Cheyenne; Grand Teton National Park; Jackson; Laramie; Laramie Co.; Lusk; Rock River, Albany Co.; Shell Canyon Falls, Bighorn Mts.; Uinta Co.;

Yellowstone National Park. ALBERTA: Calgary; Lethbridge; Medicine Hat; Scandia. BRITISH COLUMBIA: Armstrong; Lillooet (Seton Lake); Okanagan Falls; Salmon Arm; Spulanchean; Summerland; Thompson River; Vernon; Walhackin. MANITOBA: Brandon; Lyleton. SASKATCHEWAN: Swift Current.

Flower records: Apocynum sp., *Asclepias* sp., *Carduus aculescens, Centaurea americana, Cirsium* sp., *C. arvense, C. lanceolatum, C. pumilum, C. terrae-nigrae, C. undulatum, Grindelia platyphylla, Helianthus annuus, Penstemon* sp., *P. cyananthus, Rudbeckia* sp., *Solidago* sp., *Teucrium* sp., *Trifolium repens, T. pratense, Verbena* sp.

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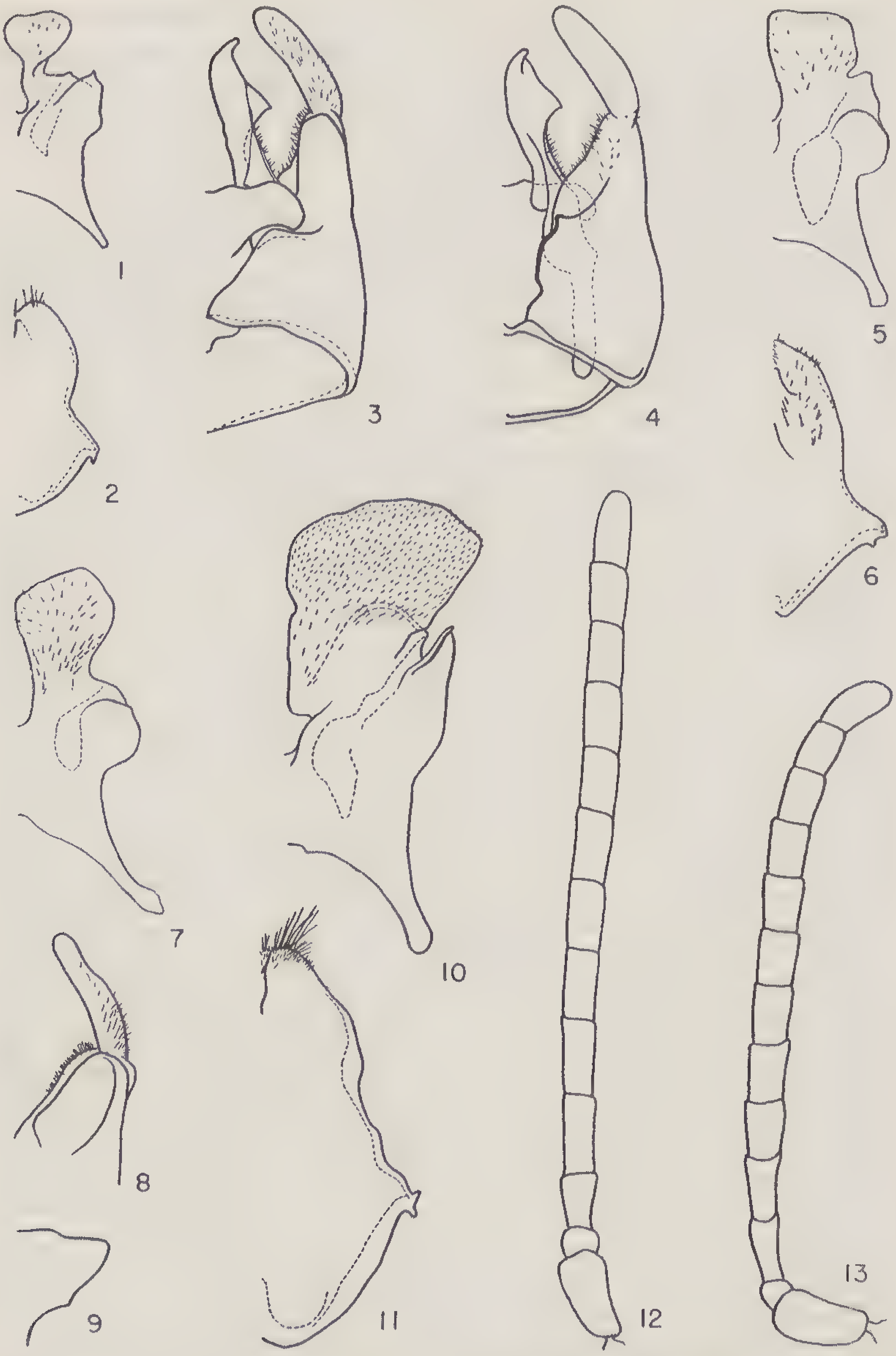

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The Biology and Morphology of *Hydrometra martini* Kirkaldy[1, 2]

BY

ISABELLE BAIRD SPRAGUE

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[1] Submitted to the Department of Entomology and the Faculty of the Graduate School of the University of Kansas in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

[2] Contribution No. 920, from the Department of Entomology of the University of Kansas.

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ABSTRACT: Both apterous and the rarer winged forms of *Hydrometra martini* occur throughout the northern part of the United States on slow moving or quiet waters. Overwintering takes place on land. Nymphs, whose behavior closely follows that of the adults, are found during the spring and summer. Individuals that will become winged may be distinguished from the apterous form as early as the third instar.

Morphological development and differential growth of the head, thorax and abdomen are traced through the less elongate nymphal stadia to the slender adult forms. The internal organs of the adult animals are similar to those of other Hemiptera but follow the attenuated body pattern.

INTRODUCTION

The purpose of this investigation is the correlation of form and function in a single species of insect, *Hydrometra martini* Kirkaldy. For this, the internal and external structures of the adults were examined and the postembryonic development of the nymphs was followed. The behavior of both nymphs and adults was observed in the laboratory and in the field throughout the year.

This species is a representative of a small family, the Hydrometridae. Of its six genera, four are monotypic. *Hydrometra,* the only widely distributed genus in the family, now includes 81 species, 47 from the Eastern and 34 from the Western Hemisphere.

The biology and anatomy of the hydrometrids is known almost entirely from the studies of the European *H. stagnorum* (Linnaeus) and the North American *H. martini* Kirkaldy. Anatomical studies of *Hydrometra* consider mainly the head with its mouth parts and the genitalia.

As in many genera of hemipterans, *Hydrometra* occurs in both a long and a short winged form. The micropterous form of *H. martini* is notably more abundant in the areas in which observations were made than is the macropterous form. However, males and females of both are found throughout the year.

ACKNOWLEDGMENTS

I wish to thank Doctor H. B. Hungerford, under whose direction this investigation has been carried out, for his patience, his encouragement and his helpful criticism. I would also like to acknowledge the critical assistance of Doctors Kathleen Doering and C. D. Michener of the University of Kansas particularly on the sections dealing with morphology.

Much of this work has been done at Mount Holyoke College and I wish to thank my colleagues there, particularly Doctor Ann Haven Morgan, for their interest and help. For the opportunity to work at the University of Michigan Biological Station, I am indebted to its director, Doctor A. H. Stockard.

MORPHOLOGY

The extremely slender, elongate form of the genus *Hydrometra,* its most outstanding characteristic, is especially pronounced in the adults. Males which average 10 mm. in length are about 0.5 mm. wide in the region of the metathorax, the widest part of the body. Females tend to be 1 to 2 mm. longer. The abdomens of those which are laying eggs are as much as 0.2 mm. wider than the metathorax.

The exoskeleton of adult hydrometrids is both hard and inflexible. The antennae, mouth parts and legs have motility because of their membranous connections and muscular attachments. The head has rather limited movement but the thoracic and pregenital abdominal segments are completely fused ventrally. The genital segments, especially those of the male, have considerable flexibility.

METHODS

Adults were killed for morphological study in 80% ethyl alcohol or in hot Dietrich's fluid, made according to directions in Kingsbury and Johannsen (1927) and stored in 80% alcohol. For skeletal structures, the insects were boiled in 10% potassium hydroxide, washed overnight in tap water and stored in 80% alcohol.

For studies of internal structures, freshly killed or fixed insects were dissected with fine needles. Muscle and nervous tissue could be demonstrated best in preserved material which was stained with eosin during the dissection. Tracheae were visible only when air-filled and the other internal structures tended to adhere to each other after storage in alcohol. These were examined in freshly killed material.

Relationships of internal structures, especially those of the head region and the nervous system, were checked in serially sectioned nymphs or recently molted adults. These were fixed in hot Dietrich's fluid, dehydrated in dioxane, infiltrated in 53° paraffin and imbedded in Tissuemat. Sections cut at 7.5μ with a Spencer rotary microtome were stained with Delafield's hematoxylin and eosin and mounted in Canada balsam.

THE HEAD

External structure

The head of the adult hydrometrid is extremely slender; those of the nymphs, especially in the early instars, are much less so. The progressive changes in proportions of the head, antennae and beak, as well as those of other regions are considered in the section on growth and differentiation (see p. 582). Almost as remarkable as the elongation of the head is its lack of clearly defined sclerites. Except for the eye, the head capsule is a heavily sclerotized tube for most of its length. The dark red, hemispherical eyes are on the more posterior part of the head. The antennal sockets form the widest part of the head. Each is set off by a suture which is best seen in lateral view (fig. 7). The antennae are four-segmented (fig. 10). The basal part of the first segment is a rounded knob which fits into the antennal socket. This segment is shorter than the second. The third segment is long and slender; the fourth is subequal to the second.

The most conspicuous sclerite in the anterior part of the head is the anteclypeus, which in lateral view (fig. 7) projects above the surrounding areas. The other sclerites associated with the mouth parts are lateral and anterior to it.

The broad labrum (figs. 5, 8) is attached to the anterior border of the anteclypeus. A median ridge of the epipharyngeal surface of the anteclypeus and labrum is produced distally to form a slender epipharynx (figs. 8, 9). The labrum forms a dorsal cover for the anterior part of the labium; the epipharynx lies within the labium, dorsal to the mandibular and maxillary stylets (fig. 14).

Ventrolateral to the anteclypeus are two pairs of sclerites which aid in the formation of the cranium. The more dorsal pair are the so-called lora, lateral extensions of the hypopharnyx (figs. 5, 12). The ventral pair are the maxillary lobes or plates (figs. 5, 20). Deep sutures separate the lora from the postclypeus and from the maxillary plate (figs. 5, 7). The outer parts of the latter are lightly sclerotized and, in younger adults, unpigmented. Ventral projections of the maxillary plates, the buccalae, partially surround the base of the beak and prevent its lateral movement (figs. 7, 20). The membranous proximal part of the labium inserts on the inner surface of the maxillary plates.

In the resting position, the beak is parallel to the head and lies close to it (fig. 7). Of the four labial segments, the third is by far the longest. It is marked, except at either end, with dark striations. The first and second segments are short and broad. The fourth, another short segment, terminates in a point. The labium is slightly flexible but the intersegmental sutures are not movable.

The edges of the labium fit together tightly (fig. 14). Cross sections of a fifth instar nymph show variations in the closure at different levels, as well as differences in width of the labium. At both the proximal and distal ends, the sides merely meet each other, whereas in the middle portion they are grooved. The epipharynx, the most dorsal structure within the labial furrow, extends only through its proximal segment. The hollow mandibular stylets are lateral to the maxillary stylets throughout their length (fig. 14). Both pairs extend to the tip of the labium and protrude from it when the animal feeds. The tips of the mandibles are spear-shaped and bear rows of recurved barbs (fig. 11).

A ridge on the right maxillary stylet fits into a groove on the left one; thus, the maxillae are locked together to form a single tube. The distal end of each maxilla bears a row of minute setae. On the left stylet these are spaced evenly (fig. 18) but on the right, they are arranged in groups of three or four which fasten together so that they appear to be heavier teeth (fig. 17).

Internal Structure

Two slender apodemes extend posteriorly from the basal segment of each antenna. A featherlike muscle attaches each of these to the side of the cranium (fig. 10). The muscle of the outer apodeme is slightly larger and is lateral to that of the inner apodeme.

Figures 11 and 19 show the mandible and its associated structures. As the stylets pass between the anteclypeus and the body of the hypopharynx, they are slightly lateral and dorsal to the maxillae. Within the head, a membranous fold attaches a vertical bar of the mandibular stylet of the rectangular mandibular lever. A second heavy membrane extends from the lower anterior corner of the lever to the lorum. A slender apodeme continues posteriorly from the mandibular lever to the occipital region of the head. The posterior part of this process is surrounded by a retractor muscle which originates on the lateral cranial wall from the posterior margin of the eye to the occiput. The protractor is a prominent fan-shaped muscle which attaches by a short, slender ligamentlike apodeme to the lower posterior corner of the lever. This muscle originates on the cranium behind the antennal socket, near the origin of the muscles of the antenna.

Each maxilla is held in place by a membranous sheath, the anterior end of which attaches to the posterolateral edge of the body of the hypopharynx (fig. 12). The sheath extends a half of the length of the stylet. Both it and the stylet itself are enveloped by the heavy protractor which has its origin on the maxillary plate. Since the stylet becomes wider posteriorly, its forward movement is limited by the sheath. The retractors, which insert on the posterior part of the stylet, originate on the occipital regions of the head capsule. The protractors insert just anterior to the retractors and pass under the hypopharynx to attach to the posterior border of the maxillary plate or lobe.

The hypopharynx consists of a medial bridge which is internal and a pair of lateral wings, the lora, which form a part of the head capsule. The maxillary sheaths and salivary syringe (figs. 12, 15) are derived from the hypopharyngeal bridge. The salivary syringe, a lightly sclerotized funnel-shaped structure, opens by a duct on the hypopharyngeal bridge just ventral to the opening of the food tube. The plunger, fitting closely into the funnel, has a very delicate apodeme which extends posteriorly near the ventral surface of the head. A heavy muscle originates on the ventral wall of the head capsule and inserts on the base of the plunger and along the length of its apodeme.

The pharynx (figs. 16, 19) is a lightly sclerotized, slender tube which extends the length of the head. Anteriorly its floor flattens to form a narrow lip which rests on the body of the hypopharynx. The mouth opening is closely associated with the tube formed by the maxillae as they emerge from their sheaths and unite to make the sucking tube. A series of straplike muscles which originate on the cranial wall and insert on the pharynx operate the pharyngeal pump. Since the origin of these muscles identifies the frons, this area extends two thirds of the length of the head to the interocular region.

Function of the Mouth Parts

A description of the food finding process and of the kinds of food used by *Hydrometra martini* is given in the section dealing with behavior. In general, hydrometrids feed on living or recently killed animals by inserting their mandibular and maxillary stylets and sucking out the fluid content.

In preparation for spearing its prey, the animal swings its beak forward, and thrusts it toward the victim with the whole body. When this is a dark shiny insect, a minute drop of saliva glistens on the exoskeleton at the point at which the stylets begin to penetrate. The saliva, secreted by the paired salivary glands located in the thorax, enters the salivary syringe through ducts on the ventral side of the head, and is pumped by the syringe through its medial duct to the groove of the maxillary stylets.

The spearlike tips of the mandibles pierce the prey and hold it so securely with their retrorse barbs that small animals can be lifted and carried considerable distances. Extension of the mandibles is effected by contraction of their protractors. This action tips the entire mandibular lever and the attached stylet forward. The mandibles retain their position while the maxillae protrude between them in feeding. The contraction of the retractor muscles withdraws the mandibular stylets.

The slender maxillary tube not only injects saliva into the prey but also carries the fluid food into the mouth. Quick thrusts of the maxillae result from alternating contractions of the protractor and retractor muscles within the head. The tips of the maxillae have a tonguelike action, lashing and gouging within the soft tissues. The actual sucking seems to result from the dilation of the food tube through muscular action of the pharyngeal dilators which originate in the anteclypeus and frons.

Discussion

The most thorough study of the structure of the hydrometrid head is that reported by Ekblom (1926). He worked out the relationships not only of the mouth parts but also of their musculature. Severadei (1950) added a description of the salivary syringe. Spooner (1938) included drawings of three views of the head and one of the mandibular lever of *H. martini* in his comparative study of the head capsules of Hemiptera. Other papers concerning the homologies of the hemipterous head are those of Snodgrass (1938, 1944, 1947), Butt (1943), DuPorte (1946) and Kramer (1950).

In *Hydrometra,* as in all Hemiptera, there has been much confusion as to the homologies and hence the names of the various sclerites. This has been especially true of the two pairs of sclerites at the anterior end of the head. Ekblom (1926) called the more dorsal pair the lamina maxillaris and the structures which surround the base of the labium, the lorae. Many taxonomists have called the dorsal pair the juga in Hemiptera. In drawings of *Oncopeltus,* Butt (1943) labeled the external portion of the corresponding lobe the juga but he referred to its internal extension as the lorum. Spooner (1938), considered the more dorsal pair of plates to be the paraclypeus and the more ventral pair, the maxillary plates.

In a paper published later in the same year, Snodgrass (1938) discussed the homologies of these sclerites. His conclusion, that the dorsal sclerites are lateral extensions of the hypopharynx, was based on the facts that: 1) although the plates adjoin the postclypeus, they are continuous with the hypopharynx in the area ventral to the anteclypeus, and 2) the protractor muscles of the mandibles originate on it. The ventral pair, Snodgrass (1944) called maxillary lobes.

In the only hemipteran which he illustrated, DuPorte (1946) designated the dorsal sclerites discussed above as the hypopharynx. Kramer (1950) working with representative auchenorhynchous Homopetra called it "lorum" and pointed out the relationship with the hypopharynx.

Both Ekblom (1926) and Severadei (1950) correlated the elongation of the head and that of the mandibular and maxillary apparatus. Ekblom (1926, 1930) described the attenuated mouth parts, especially maxillae, in several relatively short-headed semiaquatic hemipterans. In these forms, the stylets and their associated muscles extend deep into the thorax. The maxillae and mandibles of Hemiptera, like those of mandibulate insects, arise embryologically from paired evaginations of the head (Johannsen and Butt, 1941). Newcomer (1948), who investigated the development of the mouth parts of *Oncopeltus* found that the maxillary plates (= maxillary lobes) differentiate from the bases of the maxillary processes before blastokinesis. This corroborated the homology established by Snodgrass (1944), who, working with *Magnicicada* adults, identified the maxillary lobe as the stipes. Snodgrass also found that the stylet is homologous with the lacinia, and a lateral distal process of the maxillary lobe as the galea. The latter, which is present in the adult homopterans figured by Spooner (1938), is reduced or absent in his drawings of hemipterans.

In *Oncopeltus* (Newcomer, 1948), the maxillary and mandibular evaginations elongate at blastokinesis and their proximal ends sink deeply into the head. The ectoderm surrounding the base of each developing stylet invaginates to form a sac or pouch. The levers and sheaths of the maxilla and the mandibular levers are derived from the corresponding sacs.

The origin of the protractors of the maxillae on the maxillary lobe seems to be quite constant. Kramer (1950) reported this relationship in the homopterans which he examined. Ekblom (1926, 1930) described it in a variety of hemipterans. Butt (1943) and Newcomer (1948) found that in the milk weed bug, *Oncopeltus fasciatus*, the protractors also originate on the maxillary lobe. Griffith (1945) stated that in *Ramphocorixa acuminata* the protractor muscle of the maxillary stylets attach on the margins of the labial wall and on the attenuated hypopharyngeal processes.

The insertion of the protractor is typically on the maxilla near its base but below the attachment of the retractor. This is the case in *H. martini* and in all of the hemipterans discussed by both Ekblom and Butt with the exception of *Notonecta* (Butt, 1943). Here the protractor inserts on the end of the maxilla and the retractor on the side of the stylet, anterior to the attachment of the protractor.

The retractor of the maxilla extends in both homopteran and hemipteran forms from its insertion on the end of the stylet to the posterior part of the head capsule. In those forms combining unusually long maxillae with head capsules of the normal length (*Gerris, Velia* and *Mesovelia*) a pair of projections of the head capsule extend into the thorax and serve as places of attachment for the retractors (Ekblom, 1926, 1930).

A maxillary lever or bar, which is found typically in the Homoptera (Kramer, 1950), is present in *Oncopeltus* (Newcomer, 1948) and in some other hemipterans (Ekblom, 1926, 1930). In the homopterans, this lever is associated with the posterior tentorial bridge. In some, the cicada, for example, it is retracted by a muscle which arises on the tentorium and is protracted by one from the maxillary lobe. According to Ekblom (1926), when a maxillary lever is present in hemipterans, it lacks independent muscular attachments and seems to serve as a guide.

Another structure closely associated with the maxilla is the maxillary sheath. Earlier workers (Ekblom, 1926, 1930; Hamilton, 1931) considered this to be the tentorium. Spooner (1938) in his discussion of the homologies of the head capsule, reported that a true tentorium appears in the Homoptera together with the sheaths which serve as guides for the maxillary stylets. Although in the Hemiptera the tentoria are lacking, the sheaths, which he considered to be hypopharyngeal evaginations, remain.

The mandibular apparatus of *H. martini* seems to be typical of the group of semiaquatic Hemiptera. In all described homopterans and hemipterans this consists of the paired stylets each of which is supported by a lever, protractor muscles which insert on the lever, and a retractor muscle which inserts on an apodeme extending posteriorly from the stylet.

There is considerable variation in the place of origin of the protractor. According to Kramer (1950), in the auchenorhynchous Homoptera it originates on the ventral and anterior margins of the lorum. In some of the Hemiptera a muscle with these attachments is also the only mandibular protractor. Butt (1938) reported this to be the case in *Notonecta, Oncopeltus* and *Benacus,* as well as in the homopterans *Tibicina* and *Cephisus.* In the pentatomid *Acrosternum* he found an additional protractor which inserts on the mandibular lever but originates on the hypopharynx.

Ekblom (1930) described two protractor muscles of the mandible in only one hemipteran, the corizid *Myrmus miriformis* Fall. Both of these muscles insert on the mandibular lever; one on the lorum and the other on the head capsule. In the other species which he studied, the only protractor is the fan-shaped muscle arising on the cranium.

In *Hydrometra martini* the salivary syringe and its duct are similar in form, position and function to those found in the homopterans and other hemipterans (Butt, 1943; Weber, 1930). The fact that *Hydrometra* has only one groove in the maxillary tube has interested various authors since it was first described by Ekblom (1926). He and Severadei (1946) associated this with the fact that *Hydrometra* eats dead or nearly dead insects. Since the salivary glands as well as the salivary syringe are well developed, it seems likely that the single maxillary channel serves to transport both saliva and food.

The pharyngeal pump in some predacious Hemiptera (for example in *Gerris* and *Reduvius*, according to Weber, 1930) is operated by muscles which form two or three groups. In *Hydrometra* these are spread along the very long pharynx but the muscle fibers bear the usual relationship to it and to the cranium, making a V-pattern in cross section.

THE THORAX

The thorax of the wingless hydrometrids is more slender and less flexible than that of the winged forms. Figures 23 through 27 show the thorax of the wingless and figures 21, 22, 28 and 29 that of the long winged form. In both, only the metathorax is notably elongate. In addition to the muscles of the appendages, the thorax contains the esophagus, the salivary glands, the fused thoracic and abdominal ganglia, the anterior part of the heart and the thoracic tracheae. Both the adults and the nymphs lack scent glands. The skeleton and its musculature will be considered here; the other internal structures will be discussed later. Comparisons of the nymphs of macropterous and apterous forms, as well as a consideration of the progressive changes in proportion and differentiation through the nymphal instars, are also presented later (pp. 633-34).

Thoracic exoskeleton

PROTHORAX

The anterior margin of the prothorax is a heavy rim formed by the inflection of its border. The cervical membrane, continuous with this inflection, is short so that the occiput telescopes slightly into the prothorax. This arrangement limits the movement of the head in any direction.

Punctuations surround the anterior margin of the prothorax in an irregular ring and also mark the dorsal part of the pronotum (figs. 21, 23). A similar punctation marks each of the supracoxal lobes, except that of the metathoracic epimeron (figs. 22, 24).

The pronotum is continuous laterally with the pleura and forms a posterior lobe which covers the mesonotum and the anterior part of the metanotum. The large size of this posterior lobe in the winged individuals corresponds with the general difference in the size of the two forms. A fissure separates the episternal and epimeral supracoxal lobes. The first thoracic (mesothoracic) spiracle lies just behind the supracoxal lobe of the epimeron. Depressions of the sternum form the inner walls of the coxal cavities. The small furca are medial to them.

MESOTHORAX

The mesothorax of the wingless forms (figs. 26, 27) not only is smaller but also shows less differentiation than that of winged individuals (figs. 28, 29). The tergal area, which is completely covered by the posterior lobe of the pronotum, is reduced to a delicate membrane in wingless hydrometrids. In these animals the phragmata are not developed. Neither the prealare bridge nor the prealare membrane is differentiated; apparently they are incorporated in the tergal membrane. The wing pads, the bases of which are covered by the pronotal lobe, are small straplike processes near the midline of the notum.

In winged forms, the tergum is less heavily sclerotized than the rest of the exoskeleton but it is differentiated into clearly marked sclerites. The tongue-shaped first phragma projects anteriorly and somewhat ventrally from the antecostal suture. The acrotergite (precosta) is narrow. The prescutum is set off from the scutum both laterally and posteriorly by the parapsidal sutures. The posterior angles of the scutum form the tergal wing process. A wide membrane connects the scutum and scutellum laterally. The anterolateral angles of the scutellum are extended to form the axillary cords of the first pair of wings. Ventrally the wing bases are supported by the pleural processes. A pair of short processes of the scutellum articulates with the postnotum, which is represented by a pair of lateral sclerites; medially the sclerite is lacking. Neither a basalare nor a subalare is present.

Although the pleural region is similar in the two forms, it is larger in winged individuals. The pleural wing processes, which are more developed in the macropterous hydrometrids, extend dorsally and obliquely anterior from the mesothoracic-metathoracic juncture. A fissure, which is continuous with the lower part of the pleural suture, separates the anterior supracoxal lobe, formed by the episternum, from the posterior supracoxal lobe, formed by the epimeron. Each epimeron bears a second (metathoracic) spiracle. There is no separation of the mesothoracic sterna from either the pleura or the metasterna. Deep depressions of the sterna form the inner walls of the coxal cavities. The furcae, which lie just medial to these cavities, are much larger in the long-winged animals.

METATHORAX

The extremely long metathorax forms an almost inflexible cylinder which is continuous ventrally with the mesothorax and abdomen. The large episterna are fused with the sternum (fig. 27). Posteriorly these sclerites form the anterior supracoxal lobes which are separated from the small posterior (epimeral) lobes by fissures continuous with the pleural suture. The epimera are not differentiated from the abdominal pleura.

The metanotum consists of three areas. For most of its length it is a narrow internal ridge, compressed by the episterna. The second phragma, well developed in winged individuals, adheres along the ridge and expands into a broad, concave vertical plate anterior to the metapostnotum. The latter, a small triangular sclerite, lies between the episterna in the middorsal line.

The most conspicuous structure in the anterior part of the metatergum is the heavy ridge on which the posterior pronotal lobe rests. This forms an arch whose arms are medial to the mesopleural wing processes. This ridge is especially pronounced in the macropterous individuals. A less heavily sclerotized portion of the metanotum extends forward from the ridge and articulates with the mesopostnotum. Laterally a pair of triangular sclerites, evidently fragmenta of the notum, extend medially to the wing bases.

The Legs (Figs. 30, 31, 32)

The legs of *Hydrometra martini* are extremely slender. The paired claws of each leg are inserted at the apex of the third tarsal subsegment. The distal end of each tibia and the tarsal subsegments are covered with short stiff setae which are used in grooming.

Each coxa is almost completely enclosed in the cavity formed by the supracoxal lobes and the sternum. At rest, the prothoracic and mesothoracic legs extend anteriorly; the metathoracic legs, posteriorly. In each, the very large coxal process articulates with the supracoxal lobes just dorsal to the fissure between them. This articulation is lateral in the first and second pairs of legs and nearly posterior in the third.

Two small sclerites, the basicoxa and the trochantin, are associated with the articulation of the coxa. Both are present at the base of each leg and are considerably smaller in the wingless than in the winged forms. The trochantin is attached to the proximal coxal margin, anterior to the coxal process. The basicoxal sclerite, which lies behind this process, is associated with the tendon of the principal coxal retractor.

The Wings (Figs. 33 and 34)

The base of the mesothoracic wing lies between the scutal wing process and the lateral arm of the scutellum. The metathoracic wing attaches just posterior to it. Figure 35 shows the articular region in side view; the wings are lifted to show the basal sclerites.

The third axillary sclerite of the mesothoracic wing can be identified positively since the direct flight muscle (M 38), which arises on the episternum, inserts on this sclerite. Its distal projection articulates with the posterior margin of the wing. A short thick sclerite, which extends distally from the pleural wing process, articulates with the scutal wing process, the pleural wing process, the third axillary sclerite and another elongate sclerite. A heavy sclerite, which articulates also with the scutal wing process, extends along the anterior margin of the wing. Distally this sclerite makes contact with the base of a heavy vein which seems to be the proximal part of the media, since it serves as the pivot of the wing. A long arm of the first axillary sclerite extends between the second and third axillary sclerites. This sclerite is not closely associated with any of the wing veins.

There are five longitudinal veins in the mesothoracic wing. Two of these are short and run into the posterior margin. One vein, lying in the middle of the wing, extends almost its length. The other two, near the costal margin, run separately proximally and fuse with each other distally. Two cross veins connect the main longitudinal veins in the distal part of the wing.

The base of the metathoracic wing articulates with two small sclerites. One abuts on the heavy anterior vein and the other extends from the lateral arm of the notum toward the media. A heavy vein supports the base of the posterior edge of the wing.

Thoracic Musculature

Larsén (1945a, 1945b) in his comprehensive studies of the hemipterous thorax included a winged South American form. The winged *Hydrometra martini* resembles it closely, while wingless individuals lack the flight muscles except *M. furcapleuralis* (M 39). The differences, together with specific information as to the origins and insertions of the muscles, are given here with the names and numbers used by Larsén. Although they were not studied, the leg muscles distal to the coxa are listed according to Larsén's findings.

Prothoracic Muscles (Figs. 36, 37)

M 1. *M. pronoti primus.* Levator of head. Arises on pronotum and inserts by apodeme on postoccipital ridge near mid-dorsal line.

M 2. *M. pronoti secundus.* Rotator and depressor of head. Arises on pronotum and inserts on ventro-lateral part of postoccipital ridge.

M 3. *M. pronoti tertius.* Levator of head. Origin from first phragma in winged form and from anterior margin of mesonotum in wingless form. Insertion on dorsal part of postoccipital ridge.

M 5. *M. pronoti quintus.* Depressor of prothorax. Arises on lateral margins of first phragma and inserts on lateral part of pronotum. Not present in wingless forms.

M 6. *M. prosterni primus.* Depressor of head. Arises on furca and inserts on ventral margin of postoccipital ridge.

M 7. *M. prosterni secundus.* Levator of head. Arises on sternum and inserts on lateral part of postoccipital ridge near insertion of M 2.

M 10. *M. proepisterno-postoccipitalis.* Rotator and depressor of the head. Arises on the episternum and inserts on the postoccipital ridge above insertion of M 6.

M 13. *M. noto-trochantinalis.* Rotator of coxa and elevator of leg. Arises on the posterior part of pronotum and inserts by an apodeme on the trochantin.

M 14. *M. noto-coxalis primus.* Rotator of the coxa and elevator of leg. Arises on the notum and inserts with M 16 and M 17 on a tendon.

M 16. *M. noto-coxalis tertius.* Rotator of coxa and elevator of leg. Arises on notum. Insertion on apodeme associated with basicoxal sclerite.

M 17. *M. pleura-coxalis.* Rotator of coxa and elevator of leg. Arises on episternum and inserts on apodeme with M 14.

M 19. *M. furca-coxalis posterior.* Retractor of leg. Arises on furca and inserts on medial proximal border of coxa.

M 20. *M. noto-trochanteralis.* Depressor of trochanter. Arises on notum medial to M 16. Inserts by a long apodeme with M 21 and M 23 on the posterior process of proximal part of trochanter.

M 21. *M. pleura-trochanteralis.* Depressor of trochanter. Arises on episternum. Inserts with M 20 and M 23.

M 23. *M. coxa-trochanteralis medialis.* Depressor of trochanter. Arises on posterior wall of coxa and inserts with M 20 and M 21.

M 24. *M. coxa-trochanteralis lateralis.* Levator of trochanter.

Arises on anterior and lateral wall of coxa and inserts on anterior process of the trochanter.

M 25. *M. reductor femoris.* Arises on anterior wall of the trochanter and inserts on proximal part of femur.

M 26. *M. depressor tibiae.* Arises on ventral part of the femur and inserts by apodeme on the ventral part of tibia.

M 27. *M. levator tibiae.* Arises on dorsal part of femur and inserts by tendon on dorsal part of tibia.

M 28. *M. depressor tarsi.* Arises on tibia and inserts by apodeme on ventral part of 1st tarsal segment.

M 29. *M. depressor praetarsi.* Arises on tibia and inserts on the unguitractor apodeme.

Mesothoracic muscles

M 30. *M. mesonoti primus.* Indirect flight muscle; depressor of forewings. From ventral surface of first phragma and prescutum to anterior surface of second phragma. Lacking in apterous forms.

M 34. *M. dorsoventralis primus.* Indirect flight muscle; elevator of the forewings. Attaches to scutum lateral to parapsidal suture. Lacking in apterous forms.

M 38. *M. episterno-alaris.* Direct flight muscle; flexor of forewing. Arises on episternum near its upper edge, lateral M 34. Not present in apterous forms.

M 39. *M. furca-pleuralis.* Regulates position of the pleural process. Inserts on this process and arises on furca. Reduced in apterous forms.

M 40. *M. noto-trochantinalis.* Rotator of coxa and extensor of leg. In winged forms, arises on posterior part of scutum; in wingless individuals, on mesonotal membrane. In both, inserts by apodeme on trochantin.

M 41. *M. noto-coxalis.* Rotator of coxa and elevator of leg. Arises on scutellum in winged forms and on notal membrane in wingless forms. Inserts by long apodeme on lateral part of coxal margin. Insertion associated with small sclerite, free basicoxa.

M 42. *M. episterno-coxalis.* Rotator of coxa and extensor of leg. Arises on the episternum and inserts on antero-medial margin of coxal margin.

M 45. *M. furca-coxalis posterior.* Extensor of leg. Arises on furca and inserts on medial margin of coxa.

M 46. *M. noto-trochanteralis.* Depressor of trochanter. Origin on scutellum posterior to that of M 40 in winged individuals; in wingless forms on notal membrane. Inserts on a long apodeme with M 47 on ventral edge of trochanter.

M 47. *M. pleura-trochanteralis.* Depressor of trochanter. Arises on pleura and inserts on apodeme with M 46.

M 48. *M. furca-trochanteralis.* Depressor of trochanter. Arises on furca and inserts on trochanter apodeme.

M 49. *M. coxa-trochanteralis medialis.* Arises on medial coxal wall and inserts on trochanteral apodeme.

M 50. *M. coxa-trochanteralis lateralis.* Arises on lateral coxal wall and inserts on lateral wall of trochanter.

M 51. *M. reductor femoris.* Like M 26 of prothorax.

M 52. *M. depressor tibiae.* Like M 27 of prothorax.

M 53. *M. levator tibiae.* Like M 28 of prothorax.

M 54. *M. depressor tarsi.* Like M 29 of prothorax.

M 55. *M. depressor praetarsi.* Like M 30 of prothorax.

Metathoracic Muscles

M 57. *M. metanoti secundus.* Indirect flight muscle. Extensor and levator of the hindwing. Arises on third phragma and inserts on small anterior sclerite of notum. Not present in apterous forms.

M 62. *M. furca-pleuralis.* No apparent function. Arises on furca and inserts on episternum. Reduced in wingless individuals.

M 63. *M. noto-trochantinalis.* Rotator of coxa and promotor of leg. Arises on anterior part of notum and inserts on trochantin.

M 64. *M. noto-coxalis.* Rotator of coxa and retractor of leg. Arises on notal ridge. In winged forms, insertion on medial coxal margin is associated with free basicoxal sclerite.

M 66. *M. episterno-coxalis.* Rotator of coxa and extensor of leg. Arises on intersegmental line and inserts by an extremely long, slender apodeme which is lateral to other muscles and their tendons on lateral part of trochantin.

M 69. *M. furca-coxalis posterior.* Arises on furca and inserts on median coxal margin. Rotator and adductor of coxa.

M 70. *M. noto-trochanteralis.* Depressor of trochanter. Arises on notal ridge posterior to origin of M 64. Inserts with M 71 and M 72 by a long apodeme on posterior margin of trochanter.

M 71. *M. pleura-trochanteralis.* Depressor of trochanter. Arises on pleura and inserts with M 70 and M 73.

M 73. *M. coxa-trochanteralis medialis.* Depressor of trochanter. Arises on anterior wall of coxa and inserts with M 70 and M 72.

M 74. *M. coxa-trochanteralis.* Levator of trochanter. Arises on posterior and lateral wall of coxa and inserts on posterior (dorsal) margin of trochanter.

M 75. *M. reductor femoris.* As M 25 and M 51.
M 76. *M. depressor tibiae.* As M 26 and M 52.
M 77. *M. levator tibiae.* As M 27 and M 53.
M 78. *M. depressor tarsi.* As M 28 and M 54.
M 79. *M. depressor praetarsi.* As M 29 and M 55.

Discussion of the Thorax

Little was reported on the hemipterous thorax prior to the thorough studies of Larsén in 1942 and 1945. Both Gulde (1902) and Brindley (1930) called attention to the fact that *Hydrometra* lacks scent glands. In early comparative work on the thoraces of both Homoptera and Hemiptera, Taylor (1918) considered the cicada in detail. Among the other forms, he included a gerrid. Differences in the interpretation of the homologies of the various sclerites and lack of detail in the drawings make this paper and others, that on the stink bug by Tower (1913) for example, less valuable than Larsén's work in present investigations. The structure of numerous homopterans has been investigated by Kramer (1950). The thoraces in this group are markedly different from those of the Hemiptera.

In 1942, Larsén described the metathorax of a number of insects, a few of which he figured. *Gerris* was discussed in considerable detail and *Hydrometra* was compared with it briefly. In the later, more comprehensive papers (1945a, 1945b), he discussed the thoracic structure and its musculature in 26 species from 25 families of hemipterans, including a macropterous gerrid, an apterous veliid, and a macropterous hydrometrid. He illustrated the latter with two figures, one of thoracic musculature and the other of the second phragma.

The present study compared the winged and wingless forms of *Hydrometra martini* with the macropterous South American *Hydrometra*, the macropterous *Gerris rufoscutellatus* and *Velia currens* which were described by Larsén.

The prothorax of *Hydrometra martini* is apparently very similar to that of other hemipterans. The length of the pronotal lobe varies with the size of the mesonotum which it covers; both are markedly larger in macropterous than in apterous individuals.

Well-developed supracoxal lobes (the acetabular caps of taxonomists) are usually found in Hemiptera (Larsén, 1945b). The leg articulation with the trochantin imbedded in the anterolateral portion of the coxal membrane and the free basicoxal sclerite associated with the tendon of the coxal retractor (M 16) is also typical (Larsén, 1945a). Both of these sclerites are small in *Hydrometra.*

The prothoracic muscles in the wingless and winged forms are the same and like those of Larsén's species except that the apterous individuals lack the prothoracic depressor (M 5), which inserts on the base of the first phragma. Although most of the leg movement is in a horizontal plane, some elevation and depression is possible. Both the prothoracic and mesothoracic legs can swing from a nearly anterior position to a nearly posterior one.

The mesothorax of both *Gerris* and *Hydrometra* closely resembles that of other Hemiptera, characterized by a single scutal process for each wing, rather prominent parapsidal sutures, a well-developed first phragma and a scutellum which articulates with the postnotum laterally. In many of the forms studied by Larsén, as in *Hydrometra,* the postnotum consists of lateral sclerites, the median section being lacking. Laterally the scutum and scutellum in *Gerris* and *Hydrometra* are separated by a wide, lightly sclerotized band, called by Larsén the "tergalspalt." The flight muscles in *H. martini* appear to be identical with those of the species described by Larsén.

The mesonotum of the apterous form of *Hydrometra martini* shows interesting similarities to that of the wingless *Velia currens* studied by Larsén (1945a). In both, the tergal sclerites are reduced to an undifferentiated membrane. The phragma is reduced in *Velia;* in *H. martini* it seems to be lacking. In both species there is a correlated loss of the large indirect flight muscles (M 30 and M 34) and the direct flight muscle (M 38). *Musculus furcapleuralis* (M 52) which is lacking in *Velia* is reduced in *H. martini.*

The leg articulation in the winged individuals differs from that in the wingless individuals only in having larger basicoxal sclerites and larger trochantins. The muscles and leg movement are similar to those of the prothorax.

The metathorax of *Hydrometra* is markedly different from that of other hemipterans which have been investigated. In the reduviid, *Emesa,* which also has an extremely elongate body, both the mesothorax and metathorax are long and both have clearly defined tergal sclerites (Taylor, 1918). *Hydrometra* has not only a metathorax which is much longer than the mesothorax, but also a reduced tergum. That the narrow middorsal line with its corresponding internal ridge is the notum is shown by the origin of the leg muscles (M 63, M 64 and M 70) on it.

The metapostnotum, which according to Larsén (1942) can be distinguished from the metanotum by the absence of notal leg muscles, is small. *M. metanoti secundus*, an indirect flight muscle, takes its origin on it in winged animals but is lacking in apterous hydrometrids. This muscle is present in *Gerris rufoscutellatus* and absent in wingless specimens of *Velia currens*.

It is difficult to interpret the homologies of the anterior part of the metathorax. The heavy ridge which characterizes this area in apterous as well as macropterous forms of *Hydrometra martini* is not mentioned by either Taylor (1918) or Larsén (1945a) in any of the insects which they described. It seems to be a secondary development which gives rigidity to the area. No other differentiation is found in the wingless *H. martini*.

Larsén (1942) pointed out that in *Hydrometra* as well as in *Gerris*, the anterolateral angles of the metanotum are separated to form small independent sclerites above the wing bases. These serve as places of insertion for a pair of indirect flight muscles (M 57) which originate on the third phragma. He found homologous structures in a number of terrestrial hemipterans which also have a direct flight muscle (M 61) which inserts on the third axillary sclerite. Neither *Gerris* nor *Hydrometra* has this muscle. Three other landmarks of the typical thoracic region are missing: the basalare which is never found in Hemiptera as an independent sclerite, the subalare which is not found in many aquatic or semiaquatic bugs and the metapleural wing process which all hemipterans lack.

Two sclerites are present in the base of the hindwing. One, which acts as a fulcrum and extends toward the media, is probably the second axillary sclerite. The other sclerite articulates with the anterior margin of the wing and is probably the humeral plate. If this is so, the first and third axillary sclerites are missing. This area is not described by Larsén in *Hydrometra* or in any form which shows such a marked reduction of sclerites.

The extremely large size of the second phragma is made possible by the elongation of the metathorax. It has the same relative position in *Hydrometra* that it has in other hemipterans. Another effect of this elongation is the manner in which the leg muscles insert. The origins of all of the muscles are anterior to the leg base and each inserts with a long apodeme. These connections limit the horizontal movement of the hindlegs. Because of the comparatively larger size of the metepisternum, the distance between the middle and hind coxae is much greater than that between the fore and middle coxae.

Wing venation in the Hemiptera has not been the subject of recent investigation. Comstock and Needham (1898) studied a number of nymphs and figured a nymphal pentatoid wing. They found that the most conspicuous feature in these wings was the coalescence of the subcosta and radius. Two papers published in 1926, one by Hoke and one by Tanaka, described the venation in a large number of hemipterous nymphs and adults. In general, the nymphal wing includes the typical veins; the adult wing shows considerable reduction. Of those described, the wing of *Hydrometra* most closely resembles those of *Mesovelia* and *Merragata*, which were figured by Hoke. However, both of these wings have a small but clearly developed anal region which *Hydrometra* lacks. Unfortunately, neither of these papers included results of a study of positions of the wing sclerites. A thorough review of the wing venation with consideration of the basal sclerites seems to be essential for the establishment of homologies of the veins. Such a study would be interesting from the point of view of phylogenetic relationships.

THE ABDOMEN

The abdomen of the female hydrometrid consists of seven pregenital segments, two genital segments (VIII and IX) (fig. 44) and a postgenital region, the anal tube or proctiger. In the male, there are eight pregenital segments the last of which is cylindrical and partially encloses the ninth (fig. 48). The latter, the genital segment, forms the capsule which bears the external genitalia. As in the female, the postgenital area is an anal tube. The female abdomen is both longer and wider than that of the male (figs. 42, 43). The almost complete sclerotization of the adult abdomen prevents variation in total body length which is characteristic of the nymphs. This, and other aspects in the differentiation of the region, especially of the genital segments, will be considered below (pp. 600-605).

Pregenital Region (Figs. 41, 42, 43)

In both sexes, the first abdominal segment is reduced to a tergal plate. Its rounded anterior end fits closely behind the metapostnotum; in winged individuals the small third phragma arises between them. Ventrally the first segment is indistinguishable from the metathorax and the rest of the abdomen.

The ventral fusion of the definitive sterna of the pterothorax and abdomen makes flexion of the body as a whole impossible. Variation in the diameter of the abdomen is possible because of the arrangement of the dorsal sclerites. In the typical pregenital segments (II through VII) these consist of a pair of lateral plates (paratergites or laterotergites and segmentally arranged medial tergites. Each of the latter is further subdivided into a broad-ridged median, and a pair of narrow, flat lateral sclerites. The fused laterotergites of each side form long dorsolateral plates which taper to a point anteriorly and posteriorly. The junctions of the sclerites on the dorsum are membranous and allow for variation in size of the abdomen. In an unexpanded abdomen, the fused laterotergites cover the lateral part of the medial tergite of each segment. In a distended abdomen, they are raised (fig. 43).

The ventral part of the abdomen is marked laterally by a pigmented band (fig. 41). The spiracles, a pair on each segment from II through VII, lie between this line and the margin of the fused laterotergites. Segments I and VIII, which in the nymphs bear spiracles (see p. 607), lack them in the adult. The spiracles of the second segment are near the metepisterna and are more dorsal than the others. The mid-ventral line is very slightly carinate. The intersegmental lines are indicated on either side by pigmented lines. In the males, a pair of ridges project from the sternum of segment VII (fig. 41).

The pregenital region of the mature adult lacks intersegmental longitudinal muscles. In fifth instar nymphs and in very recently molted adults, five or six heavy muscle fibers run from one intersegmental ridge to another on either side of the middorsal and mid-ventral lines. In both nymphs and adults, each abdominal segment has a series of straplike dorsoventral muscles which attach to the laterotergites dorsally and ventrally to the sternum at the level of the pigmented band.

Female External Genitalia (Figs. 44, 45, 46, 47)

The terminal segments of the female hydrometrid are covered dorsally by the eighth tergum and ventrally and laterally by the first valvifers. The first valvifers hinge on the lateral margins of the triangular eighth tergite (fig. 46) and extend ventrally nearly to the mid-line (fig. 45). The ventrolateral portions of these sclerites are partially telescoped into the seventh segment, which extends back to form a subgenital plate. The proctiger, bearing the anal opening, and the tips of the second valvulae project posteriorly between the first valvifers (fig. 46).

Figure 47 is a diagram of the region with the left anterior valvifer and the left side of the seventh segment removed to expose the other structures. The retractor muscles of the valvifer which arise on the seventh sternum and the membranous lining of this valvifer are also removed. The first valvula hinges on the inner surface of the first valvifer. The vagina passes between the first valvulae which nearly surround the wide vulva. The second valvifers are dorsal and medial to the first. Together they form an egg guide rather than a true ovipositor. The second valvulae, or gonapophyses, either are lacking or are incorporated in the valvifers.

Two pairs of muscles originate on the seventh sternum. One pair attaches to the anterior margin of the first valvifer; the other inserts by a long apodeme on the first valvula. The protractors of the first valvulae arise on the eighth tergum and attach dorsally. The two muscles of the second valvifer arise on the lateral margin of the small ninth tergum. The anal muscle takes its origin on the seventh tergum and inserts by a slender apodeme which extends under the ninth tergum to the posterior part of the proctiger.

Male External Genitalia (Figs. 48, 49, 50, 51, 52)

In the male hydrometrid, the membrane which attaches the eighth abdominal segment is extensible enough to allow flexion of approximately 60° (fig. 48). Its movement is produced by two pairs of muscles which arise on the seventh segment, one laterally and one ventrally. The ninth segment, the genital capsule, is partially telescoped into the eighth. The connecting membrane here too allows for movement; the capsule can twist laterally about 90°. Two pairs of intersegmental muscles, originating laterally and ventrally on the eighth segment, insert on it.

The outer surface of the entire capsule is rigid but the dorsal margin, and particularly its lateral angles are extremely heavily sclerotized. The portions usually enclosed by the eighth segment are lighter in color and less heavily sclerotized. The ventral wall of the genital chamber, formed by the concave inner lining of the capsule, is lightly sclerotized.

The proctiger, or anal tube, projects from the basal part of the ninth segment and forms a partial cover for the genital chamber (fig. 50). The large basal plate which articulates with the capsule posteriorly is nearly concealed (fig. 51). This plate is a sclerotized ring with a median dorsal projection. The tubular phallosoma or phallobase extends from it and the genital claspers (parameres, harpagones, gonoforceps, genitalhaken) articulate with it laterally. The aedeagus is telescoped within the phallobase.

When the genital apparatus is evaginated, the phallobase and the aedeagus extend perpendicular to the capsule. The lightly sclerotized valves of the aedeagus are imbedded in its ventral wall. The tip of the aedeagus is elongate (fig. 52). The claspers are paddle-shaped and each bears four or five setae on its anterior margin (fig. 49).

The musculature of the genital capsule is shown in figure 49. Two small muscles, one of which arises anteriorly and the other posteriorly on the genital capsule, insert on the base of each clasper. Protraction and retraction of the phallobase are caused by two pairs of muscles arising anteriorly and laterally on the genital capsule and inserting on the basal plate. The protractors are broad flat muscles which originate on the ventral part of the capsule, extend under the lining of the genital chamber and attach broadly to the medial part of the basal plate. The retractors are fan-shaped muscles which arise on the lateral walls of the capsule and insert by a tendon on the lateral projections of the plate.

Discussion

Work on the hemipterous abdomen has been concerned especially with the genitalia. Some studies have included the number of abdominal segments and others have dealt with patterns of sclerotization of this region. The most detailed paper considering all the aspects of the abdomen and the genitalia is that of Larsén (1938).

Typically, the first abdominal segment of hemipterans is reduced as it is in *Hydrometra* (Larsén, 1938). In the adult the first tergum is separated from the second by a faint line. Also, the presence of eight pregenital segments, the second through the seventh bearing spiracles and the others lacking them, is typical of this order (Snodgrass, 1935). In adult hemipterans, the postgenital region always consists of a small sclerotized tube which is considered to represent the fused tenth and eleventh abdominal segments (Snodgrass, 1935; Larsén, 1938). This region has been referred to as the proctiger (Snodgrass, 1935), Analkonus (Larsén, 1938), anal lid (Ekblom, 1926), Analkegel (Weber, 1930). Eleven abdominal segments develop embryologically in *Naucoris, Nepa* and *Notonecta* (Heymons, 1899) and in *Pyrrhocoris* (Seidel, 1924). The embryological development of *Hydrometra* is not known but the nymphs as well as the adults have only ten distinct segments.

The arrangement of the dorsal and ventral intersegmental muscles of *Hydrometra* shows clearly the nature of the primary segmentation of the pregenital region. Although the loss of these muscles is not reported in hemipterans it correlates with the loss of flexibility, since these muscles, essential for the final molt, have no function in the adult insect.

The lateral margin of each abdominal segment in many hemipterans is differentiated into a laterosternite as well as a laterotergite (Snodgrass, 1935; Larsén, 1938). These lateral sclerites are considered together as the connexivum (Torre-Bueno, 1937), a structure which is frequently mentioned in taxonomic descriptions (Blatchley, 1926; Hungerford and Evans, 1934). Only the laterotergites are formed in *Hydrometra,* and in most species of the genus, each of these is independent of the others. However, in a number of species, including *H. ambulator* Stål, *H. albolineata* Scott, *H. butleri* H. & E. and *H. greeni* H. & E., which Hungerford and Evans (1934) figured in dorsal view, as well as in *H. martini,* the laterotergites of each side form fused lateral plates.

According to Snodgrass (1935), the spiracles of the insect abdomen lie in the tergum. Their location in *Hydrometra* indicates the incorporation of a part of the tergum into the definitive sternum, which Snodgrass illustrated as a variation in the pattern of abdominal sclerotization. The origin of the dorsoventral abdominal muscles on the wall of the definitive sternum ventral to the spiracles shows that this region is a part of the sternum. If any pleural area is present, it must, therefore, be incorporated in the narrow band between the spiracles and this line of muscle insertion.

By far the most thorough comparative work on hemipterous genitalia is that by Larsén (1938) mentioned previously, who reported on the reproductive systems of several aquatic species. The earlier papers of Ekblom (1926, 1930) described the male and female genitalia as well as head structures in a variety of hemipterans, including *Hydrometra stagnorum.* Comparisons of the male external genitalia in a large number of species were figured and discussed by Singh-Pruthi (1925). Snodgrass (1933) included descriptions of female genitalia of a coreid, *Anasa tristis,* and a saldid, *Pentacora ligata.*

According to Larsén (1938), the female genitalia of Hemiptera typically include two pairs of valvifers (gonapophysistrager), the anterior bearing the first valvulae (gonapophyses) associated with the eighth segment and the posterior, associated with the ninth segment, bearing the medial (second) and lateral (third) valvulae (gonapophyses). The lateral gonopophyses do not take part in the formation of ovipositors in Hemiptera. Snodgrass (1933) and Michener (1944) homologized the third valvulae with the gonostyli of primative insects. Larsén (1938) found that in typical Hemiptera the muscles of the first valvifer include one from the seventh sternum and two others from the eighth tergum; those of the second valvifer arise on the ninth tergum. In the corixids, the only family which he considered in which the female genitalia are greatly reduced, the valvulae are small and incorporated in the valvifers. This may be true also in *Hydrometra.* The relationships of the sclerites correspond with the description by Snodgrass (1933) of hemipterans.

Ekblom (1926) found that although the ovipositor in *Hydrometra* was greatly reduced, it resembled those of *Gerris* and *Velia.* There are other minor differences between *H. stagnorum* as described by Ekblom and *H. martini.* In the former, the ninth tergum and proctiger are larger and the sternum of the seventh segment extends much farther posteriorly.

The origins and insertions of the various muscles help to establish the homologies of the sclerotized parts. These have been investigated by Snodgrass (1933) and Larsén (1938). The muscles of the ninth segment are, typically, as they are in *Hydrometra,* two pairs arising on the tergum and inserting on the second valvifer. Usually two ventral muscles which originate on the seventh sternum, insert on the first valvifer. In *Hydrometra,* only one was found both in this study and in that of Ekblom (1926). The position of the dorsal muscle, arising on the eighth tergum and inserting on the dorsal part of the first valvula is typical.

The hemipteran male genitalia consistently include a genital capsule, formed from the ninth segment, which bears the intromittent organ and a pair of articulated appendages (Snodgrass, 1935; Larsén, 1938). The species studied by Ekblom (1926, 1930) and Larsén (1935) have intromittent organs consisting of a sclerotized proximal portion (phallobase or phallosoma) and a rather membranous distal portion (aedeagus). The aedeagus is extremely variable in shape; in *H. stagnorum* it is long and tapering (Singh-Pruthi, 1925).

In Hemiptera, the phallobase attaches to the basal plate. The retractor and protractor muscles, which arise on the genital capsule, insert on this plate rather than on the phallobase or the aedeagus. Both the position and the musculature of the genital claspers in *Hydrometra* are of the typical hemipterous pattern.

Although the male external genitalia in Hemiptera are consistent in their form, the homologies of the various structures are not yet clearly understood. Snodgrass stated that "concerning the origin of the insect phallus, we can say only that the facts at present known about the development of the organs are not sufficient to warrant any definite statement, but that they appear to favor the view that the phallus is an independent genital structure" (1941, p. 8). However, Michener (1944) was able to work out the homologies of male and female structures by using gynandromorphs and intersexes of a number of species of Hymenoptera and Orthoptera. Assuming that these homologies apply to the Hemiptera, the basal plate represents the fused proximal portions of the gonopophyses and the genital claspers represent either the gonocoxite alone or a fusion of the gonocoxite and the gonostylus.

An interesting report by Wygodzinsky (1947) suggested that the male claspers of the cryptostemmatid, *Trichotonannus,* are serially homologous with ventrolateral, spiracle-bearing extensions (which he termed "parasternites") found on abdominal segments seven and eight. Wygodzinsky proposed the theory that this is a primitive condition retained by the cryptostemmatids which he believed to be more closely related than most other families to generalized Hemiptera.

INTERNAL ANATOMY

The Digestive System (Figs. 53, 54)

The pharynx of *Hydrometra martini* is readily identified in cross section by its characteristic U-shape and dilator muscles. It extends nearly to the posterior margin of the head. Here the digestive tube is surrounded by nervous tissue and changes to the esophageal pattern, which is round in cross section. In the prothorax, the alimentary canal emerges from the circumesophageal ring and continues posteriorly, margined on either side by the principal salivary glands. These are composite structures with lobules of four types (fig. 53). Those of the most anterior group are transparent; small and vesicular. The others are translucent and of variable shapes; one group is elongate, the next, ovate. The posterior part of the gland is a single large, round acinus. The accessory gland consists of a median, a lateral and a posterior lobe, each of which is elongate and thin-walled. A duct connects this gland with that of the primary gland and a second duct leads anteriorly to join that from the opposite side. The common duct extends anteriorly just ventral to the digestive tube.

At the level of the mesothorax, the esophagus widens to form the broad anterior part of the ventriculus, which extends back to the fourth abdominal segment (fig. 54). The next section of the ventriculus, a narrow tube, continues posteriorly to the middle of the fifth segment, loops back to the level of the fourth segment and then turns posteriorly again. At the level of the sixth abdominal segment, the ventriculus enters the thick-walled intestine. The Malpighian tubules, two on each side, enter the alimentary canal at this level. These twisted, white tubules extend into the fifth and seventh segments.

The intestine continues to the posterior part of the seventh abdominal segment, where it joins the rectum, a short, thin-walled tube. A large diverticulum, which is an evagination of the ventral wall of the rectum, extends under the intestine. The rectum passes through the proctiger and opens to the exterior at its tip.

The Female Reproductive System (Fig. 55)

The ovaries of *Hydrometra martini,* consisting of seven ovarioles or egg tubes, extend from the thorax through the sixth abdominal segment (fig. 55). Each egg-tube has an anterior terminal filament, a group of undifferentiated cells and a series of eggs of which the most posterior is the most nearly mature.

The combined terminal filaments join dorsally between the digestive tube and the metathoracic leg muscles and hold the ovaries in place. The ovarioles of each ovary open into a short oviduct which joins with that of the other side to form the common oviduct. The wall of the common oviduct is thickened anteriorly and leads posteriorly to the vagina. The seminal receptacle, which also enters the anterior part of the vagina is made of two parts—a slightly twisted duct and a flat gland which contains long, coiled and very slender tubules. Posterior to the base of the seminal receptacle, the vagina is enlarged to form a muscular bursa copulatrix. On its dorsal surface is a heavily sclerotized evagination. The vaginal opening, the vulva, lies between the valvifers of the eighth and ninth abdominal segments.

Recently molted or overwintering females have inactive ovaries which are small and compact. The females which are reproductively active may have tremendously enlarged ovaries with as many as seven mature or nearly mature eggs. Those females which have mated may have masses of sperm in both the dorsal evagination of the bursa and the seminal receptacle.

The Male Reproductive System (Fig. 56)

The internal reproductive organs of the male are simple (fig. 56). The elongate testes of the sexually active male extend from the first through the fifth abdominal segments. In immature and in over-wintering individuals these may be less than half the size of the active testes. A slender duct, the vas deferens, leads from the anterior end of each testis along its median margin to the seminal vesicle. These vesicles have rather muscular walls and large lumina. In living males which are dissected, masses of sperm are moved back and forth in the vesicles by contractions of the walls. The narrow duct of each seminal vesicle joins that of the other side to form a common ejaculatory duct which enters the genital capsule. There are no accessory glands.

Organs of Conservation, Respiration and Distribution

Layers of cells, many of which are fat-ladened, lie between the exoskeleton and the internal organs. In many individuals, especially those dissected in the early spring, these cells are bright green, while in other animals, they are white. The ventral and lateral walls of the abdomen are lined with a continuous double-layered sheet of this tissue through which numerous tracheal tubes spread. A double layer of cells spreads under the tergal area of the abdomen and both tracheae and a part of the dorsal blood vessel are imbedded in it.

The positions of the spiracles were described above (see p. 600 and fig. 41). Of the eight pairs, only the first has a closing apparatus. The short atrium lies between the external opening and a valve consisting of a process on one side which closes against the opposite wall. The other spiracles open directly into spiracular trunks. The short spiracular trunk gives off three main tracheae: one which sends branches ventrad and obliquely caudad, another which supplies the viscera, and the third which goes to the dorsal layer of cells. Branches of the dorsal tracheae, which join corresponding tubes of the adjacent body segments, form a dorsolateral trunk. These large trunks extend anteriorly and posteriorly to the body segments which lack spiracles. Branches from them supply the various tissues. No vessels were observed to connect the tracheae of the left and right sides.

The dorsal blood-vessel extends from the seventh abdominal segment to the level of the deutocerebrum. In the abdomen, it lies in the dorsal diaphragm. In the thorax and head it parallels the anterior portions of the ventriculus and the esophagus. There is no obvious variation in diameter in the anterior and posterior parts of the vessel. The fine structure of the vessel was not studied; but in stained whole amounts of the dorsal body wall and blood vessel, two cell layers are evident. The inner layer consists of flat epithelial cells with flattened nuclei and nongranular cytoplasm. The cells of the outer epithelium are cuboidal; the nuclei are round with large nucleoli and the cytoplasm is granular. Many of the surrounding cells have large fat droplets. Others are smaller with centrally placed nuclei and granular cytoplasm.

Nervous System (Fig. 13)

The ganglia of the central nervous system are concentrated in the posterior part of the head capsule and the prothorax. Their fusion is nearly complete but there are indications of the original ganglia in both dissected and sectioned material. The optic nerves extend from the protocerebral ganglia. These and the deutocerebrum are not contiguous medially since the pharynx with its dilator muscles lies between them. The dorsal blood-vessel opens between the bases of the deutocerebral lobes. The large tritocerebral ganglia are fused and, together with the circumesophageal connectives and the subesophageal ganglia, make a heavy ring of nervous tissue through which the esophagus and the dorsal blood vessel pass. In the thorax the esophagus emerges from this concentration of nervous tissue and continues posteriorly dorsal to it. The thoracic concentration consists of four ganglia. Since nerves of the first, second and third ganglia innervate the legs, these are clearly thoracic. The last ganglion gives off two pairs of nerves, one directed obliquely and the other posteriorly, and represents the fused abdominal ganglia.

Discussion

In general, the structure of *Hydrometra* seems to be similar to that of other hemipterans described in the literature. Among the studies on the internal anatomy of the group, that of Dufour (1833) remains the most comprehensive. Weber (1930) and more recently Poisson (1951) have brought together information on morphology in their general works on the Hemiptera. Other than the papers mentioned earlier on the structure of the head, thorax and external genitalia, only two mention original work on the anatomy of *Hydrometra.* One by Gross (1901) concerns the number of ovarioles in the female *H. stagnorum* and the other by Mammen (1912) deals with the spiracles in the same species. *Hydrometra martini* will be compared here for the most part with *Gerris,* which has been studied by numerous morphologists.

The digestive system of *Hydrometra* is very similar to that of *Gerris canalium* as described by Dufour (1833). In *Gerris,* the ventriculus is figured as being constricted anteriorly and having a prominent pouch just before its entrance into the intestine; in *Hydrometra,* it is a simple sac. Both kinds are figured for various hemipterans by Elson (1937) who also found forms in which the extremely long ventriculus had four subdivisions and others in which there were numerous gastric caeca. In this study, in which he compared the length of the alimentary canal with the total body length of hemipterans with different feeding habits, Elson found that the predatory forms, *Belostoma* and *Notonecta,* had digestive tracts three times the body length, the phytosuccivorous forms, twice the body length and the algophagous forms, one and a half times the body length. In *Gerris,* as well as in *Hydrometra,* the alimentary canal is about one and a half times the body length (Dufour, 1833).

Dufour showed three pairs of salivary ducts entering the head in *Gerris.* In *Hydrometra,* as in the coreid, corixid and belostomatid examined by Elson (1937), a single duct is present on each side. Dufour mentioned the possibility that the accessory salivary glands serve as reservoirs. Certainly their thin walls and large lumina have the appearance of storage rather than of secretory activity.

The posterior part of the digestive tract, in all of the described Hemiptera consists of a short intestine into which open four Malpighian tubules and a thin-walled rectum with a large ventral diverticulum (cul-de-sac or sac stercorale) (Elson, 1937). According to Poisson (1951) this structure may serve as a hydrostatic or a respiratory organ in the aquatic hemipterans. Its function in other insects is not known.

The internal organs of reproduction of *Hydrometra* have not been described except that Gross (1901) reported that each ovary of *H. stagnorum* consists of four ovarioles. This is the minimum number found in hemipterans, whereas seven, the number found in *H. martini,* is the maximum (Weber, 1931). Besides the differences in numbers of ovarioles, variations in the female pattern seem to involve the vaginal region. Both Dufour (1833) and Wilke (1908) included figures of the female *Gerris* but neither showed this area. Of the aquatic hemipterans considered by Larsén (1938) only in *Micronecta minutissima* is the vaginal cuticule modified as it is in *Hydrometra martini* to form a chamber in which sperm can be stored. In both species, sperm are found here as well as in the seminal receptacle.

The male reproductive system of *Hydrometra* is similar to that of *Gerris lacustris,* as described by Wilke (1908) and of *Velia currens* as described by Dufour (1833). In *Gerris,* the testes are U-shaped; the ducts and the seminal vesicles are broader than those of *Hydrometra.* In *Velia,* the testes are shorter and the vasa diferentia emerge from nearly the middle rather than at the anterior end of the gland. In all three species, the ejaculatory duct is straight and lacks accessory glands.

The tracheae of the abdominal segments of *Hydrometra* follow the general pattern described by Snodgrass (1935). The structure of the spiracles, the first pair having a closing apparatus and the others lacking it, was found in both *Gerris* and *Hydrometra stagnorum* by Mammen (1912). Dufour (1833) commented on the sparcity of tracheal tubes in the gerrids which he examined and correlated this with their low rate of activity and their less frequent flight. Dufour noted also the relationship of the tracheae with the tissues under the exoskeleton which serve in fat storage.

The dorsal blood-vessel is usually divided into an abdominal region which bears ostia and is heavier walled than the anterior part, or aorta (Snodgrass, 1935). In the stink bug, *Nezara,* there are three pairs of ostia in the abdominal section (Malouf, 1933). These structures were not seen in *Hydrometra.*

The comparative study of the nervous systems of Hemipterans published by Brandt in 1878 continues to be the most comprehensive work in the field. The nervous system in this group is characterized by a concentration of ganglia. Various combinations of ganglia occur in the different species. In *Gerris,* as in *Hydrometra,* the subesophageal ganglia are connected broadly with both the circumesophageal commisures and the combined thoracic and abdominal ganglia. However, in *Gerris* the eyes are relatively close to the central nervous system and the optic nerves are correspondingly short. In other species, the ganglia may be fused in other patterns; there may be two or three concentrations joined by relatively long connectives.

BIOLOGY

Hydrometra martini was collected in and near South Hadley, Massachusetts from 1948 through the spring of 1955 and in the vicinity of Douglas Lake, Cheboygan County, Michigan in the summers of 1948, 1949, 1951 through 1954. In both areas, it was abundant in pasture ponds, in small lakes and in other still or slow-moving waters having plant-lined shores supporting abundant animal life.

Descriptions of Habitats

In the South Hadley area, hydrometrids were found most readily in and on the shores of spring-fed pasture ponds at Lithia Springs in South Hadley and at Whately Glen in the town of Whately. They were also taken at Upper and Lower Lakes on the Mount Holyoke College campus, Paradise Lake in South Hadley, Aldrich Lake in Granby and the Old Mill pond in Hadley.

The Whately Glen pond, which is approximately 40 m. long and 30 m. wide, is fed throughout the year by springs at its northeast end. On the north and west sides of the pond, the banks slope gradually. The bottom, which is covered here with a thick flocculent ooze, becomes sandy near the southern end where the outlet has been dammed. Cattails (*Typha latifolia*) are the principal vegetation of the spring-fed area. Bur-reeds (*Sparganium americanum*) emerge from the bottom mud and through the summer and fall, a thick scum of algae fills the spaces between their bases and lies over the decaying leaves. *Myriophyllum* is rooted in the deeper water.

From late spring to early fall the shore and the matted vegetation support a varied population of animals. Among them are collembolans, gerrids, lycosid spiders, mesoveliids, hebrids, and *Microvelia,* as well as hydrometrids. Large numbers of entomostracans, hydrachnids and dipterous larvae swim through the shallow water. Dragonfly and damselfly naiads, corixids, notonectids, naucorids, and larval and adult beetles dart through the open water or crawl over the submerged vegetation. Larger animals, *Rana clamitans, Triturus viridescens* and *Chrysemys picta* also live in the pond.

In the autumn, the leaves of the oak and maple trees and the needles of the white pines, which surround the pond, drop into the water. The bur-reeds turn brown and fall, making a floating raft before they sink to the bottom. In this period the hydrometrids migrate to land; gerrids and gyrinids disappear from the surface. Spotted newts become more abundant as the red efts return to the water and change to their green and yellow colors. On the land, arachnids, cicadellids, and staphylinid beetles crawl among the grass hummocks and dead leaves with the hydrometrids. Until snow falls in the early winter, marsh treaders are found on the moist earth in protected places, depressions among clumps of grass, and under dead leaves. In most years, the snow- and ice-covers last until the spring rains in late March.

The pasture ponds at Lithia, which is also spring fed, is nearly round with a maximum diameter of approximately 10 m. It lies in a hilly pasture surrounded by *Tsuga, Chamaecyparis, Juniperus* and *Kalmia. Iris* and *Typha* surround the margin of the pond, and *Vallisneria* and *Myriophyllum* cover its floor. In the early spring as the ice melts, fairy shrimp, *Eubranchipus vernalis* and larvae of the limnophilid caddis fly, *Platycentropis,* appear. *Rana sylvatica* and *Ambystoma maculatum* come in to lay their eggs. Tadpoles of *R. catesbiana* and *R. clamitans* are present through the year as are *Triturus viridescens* adults. Many species of water beetles and a variety of hemipterans (*Ranatra, Notonecta, Belostoma* and *corixids*) are to be found in the water, and gerrids and gyrinid beetles, on its surface. In late summer, if there has been little rain, the pond shrinks to about a tenth of its maximum size; the animal population is concentrated. With the fall rains, the water level rises so that the pond is well filled before the ice forms. This pond, too, is covered with snow from late December until March.

In the Douglas Lake area, hydrometrids occur in varying numbers in many habitats, bog lakes, beach pools, slow moving side waters of creeks and man-made pools. Among these are Nichol's, Smith's and Bryant's bogs, Bessey Creek, Nigger Creek, Fontinalis Run, the beach pools at Sedge Point on Douglas Lake and at Black Lake, Nelson Lake and the gravel pit pools near Pellston. Collections and observations were most frequently made at the gravel-pit pool near Pellston and at Nelson Lake because they were more accessible and hydrometrids were relatively abundant there.

The gravel-pit pools are four miles north of Pellston on the east side of highway 31. Irregular in shape and in depth, they occupy an area approximately 25 m. long and 16 m. wide. They were made by the removal of gravel to a depth of two to three meters at least 15 years ago. The sources of water are springs on the north side and drainage from the adjacent area; there is no outlet. The water level fluctuates greatly. In each of the years in which collections were made, the pools were well filled during the early summer. In 1951 and 1952, rains were frequent through the summer and the water level remained rather high in August. Even in these years, the shallowest place dried completely. In the drier years, 1948 and 1949, the deepest depressions held only about 0.5 m. of water by mid-August. Emergent vegetation, consisting mainly of *Typha,* is limited to these deeper areas in which decomposing material has formed a deposit. *Chara* beds cover the bottom and *Juncus* with some *Carex* grows in the shallow water and along the shores. Clumps of *Cornus stolonifera, Salix lucida* and *Salix subsericea* overhang the north banks. A great variety of aquatic and semiaquatic hemipterans, notonectids, corixids, *Belostoma, Lethocerus, Ranatra, Gerris, Hebrus,* saldids as well as *Hydrometra,* abound here. Other insects include bettle larvae, soldier fly larvae, damsel fly, dragon fly, and mayfly naiads. Amphibian tadpoles and metamorphosing frogs and toads are present in numbers.

Nelson Lake lies on either side of a gravel road separating sections 15 and 22 in Hebron township (Row 3W, Tier 38W), Cheboygan County. The lake is a low marsh about 8000 m. long and 3000 m. wide. Earth was thrown up to make a causeway on which the road runs. The ditches thus made are considerably deeper than the rest of the area. In dry years, in 1948 and 1949 for example, the water evaporated from the entire area, except the roadside ditches, causing concentrations of animals here. The soil is yellowish sand except for the detritus which accumulates in the deeper water. *Spirea* and *Salix* grow along the road and the willows extend to the edge of the water. The marsh is covered with a mixture of *Juncus* and *Scirpus* with some *Carex* and *Dulichium. Potomageton* and *Polygonum* grow in the deeper water. The animals here are of the same groups represented at Pellston. However, *Spongilla* is common and the amphibious snails, *Succinea,* are extremely abundant.

Collecting Methods

Adult hydrometrids were caught easily by hand or with a small tea-strainer and were transferred to an aspirator. They survived transportation best either in a dry container or in one which was lined with paper to absorb excess moisture. The nymphs were collected with a strainer and an aspirator with damp paper in the bottom. The nymphs were subject to death by desiccation if they were left too long in dry containers and by drowning if caught in condensation of moisture on the glass. They survived best when kept in containers which were lined with moist paper.

Both in the field and in the laboratory, cannibalism was prevalent among the nymphs. The harder bodied adults seemed invulnerable.

Rearing Methods

In the laboratory, hydrometrids lived well in aquaria with plants extending to or above the surface or in dishes partially filled with wet sand. They lived equally well in covered containers lined with several layers of moist towelling paper. This method has several advantages; the eggs could be removed and the nymphs and their molted skins were easier to see. These containers could be cleaned by removing the top layer of paper. The eggs were removed and placed on moist paper in containers. Because of cannibalism, the mortality rate was high unless the hatching nymphs were isolated and reared separately.

Hydrometrid nymphs and adults feed on any recently killed insects. Because of the ease with which they can be handled, fruit flies having vestigal wings were used to a large extent.

BEHAVIOR OF THE ADULTS

Locomotion

Hydrometrids are equally at home on slowly moving water, on floating or emergent vegetation, or on moist earth. In warm weather they are most active near aquatic vegetation but sometimes individuals venture 4.5 or 6.0 m. on the open water. On cool or cloudy days, hydrometrids most often seek the shore vegetation, sometimes climbing 25 or 30 cm. on the cattails or sedges.

Their typical gait is the deliberate walk that has given them both their common names, marsh treader, and water measurer. They do not glide or hop as do the gerrids, but a disturbed animal runs rapidly from danger.

As a hydrometrid walks it typically swings its antennae from side to side. Both in the laboratory and in the field, the adults and nymphs characteristically elevate and lower their bodies by the rapid bending of the legs at the femerotibial junction either when the animal is moving or stationary.

A frequent activity is the grooming of the appendages. The insects repeatedly draw their antennae or beak between the setose tarsi of the front legs or rub their legs against each other. Resting insects often raise one leg while standing on the others. This may also hasten evaporation of water from the tarsi.

Complete cessation of activity occurs only during cold weather; the animal takes a flattened position in which the antennae and legs are outstretched, the front and middle legs anteriorly and the hind legs posterolaterally.

Under-water activity is limited to accidental incidents since hydrometrids never seem to submerge themselves deliberately. An experimentally immersed adult is lighter than water because of the air film held by body pubescence. It sucks air into its digestive system either from this film on the ventral side of the body or, if its body touches the water surface, by extending the beak through the film and drawing in air. The insect then swims or sculls along the surface to emergent vegetation or the shore and walks out. By intensified grooming, the insect soon dries its appendages.

Macropterous individuals exhibit the same behavior patterns as the micropterous forms. However they can fly well. Twice animals kept in the laboratory flew from their containers. The flight, which was preceded by fluttering of the wings as the animal walked, was almost vertical for about a meter. One animal flew to the window; the other disappeared in a few seconds and was not recovered. Flight was not observed in the field.

Feeding

When food is available continuously under laboratory conditions, the adults begin to feed not sooner than three hours but usually not longer than five hours after the molt.

In the laboratory, hydrometrids appear willing to eat any sort of freshly killed or inactivated insects. Small living insects, such as nymphal hydrometrids are devoured readily. They take plankton animals and aquatic larvae, mosquito wigglers and blood worms, for example, spearing them under the surface film. In the field they were observed to eat adult midges, mosquito wigglers, cladocerans, ostracods and collembolans. Usually a feeding insect was seen only after it had impaled its victim and was carrying it. On seven occasions, most of them during the summer of 1950, adult hydrometrids were observed to spear living aquatic forms (3 cladocerans, 2 mosquito larvae and 2 ostracods). No field records were made of hydrometrids feeding on large insects or of several individuals sharing a victim.

In seeking food, the insect stalks with its lowered antennae swaying from side to side, as though they were helpful in locating the prey. As the animal approaches food, it swings its beak forward and with a movement of the whole body, impales its victim.

The process of securing and holding the prey with the retrorsely barbed mandibles and probing out the juices with the maxillary stylets has been described in the section dealing with function of the mouth parts (p. 585).

The use of saliva in feeding was brought out in the discussion of the head structure. The size and degree of differentiation of the salivary glands and the drop of fluid which can be seen occasionally as the beak of the hydrometrid touches its prey, indicate the activity of the glands. In addition, the victim is paralyzed quickly; one which is attacked and almost immediately released soon dies.

In the laboratory, the imbibing of water by adults was observed only when the animals were changed from a dry container to one with water. Those kept in a damp situation probably obtained enough with their food.

Overwintering

In Massachusetts the hydrometrid population in late September and October consists of adults, apparently young, and 5th instar nymphs. The females are sexually immature; the abdomen is slender and the ovaries are small. When the temperature approaches 15°, usually in mid-October, the landward migration starts. In the warm fall of 1951, this movement was delayed until October 25th. At the beginning of the migration at Lithia, a few individuals can be seen walking up the gently sloping north bank. Within ten days of the onset of migration, all of the individuals are off the water. Nymphs are rarely found; those taken into the laboratory at this time molt in one to three days.

Through the winter, when the ground is not snow-covered, adult hydrometrids are found singly or in small groups on the moist ground near the ponds at Lithia and at Whately. Usually they are among the decaying vegetation or in depressions among the grass roots. In the coldest weather, the animals which are completely inactive assume the resting position described above (see p. 616). Their inactivity combined with their earthlike coloration renders them nearly invisible. If these animals are touched, they arouse themselves and walk away slowly.

Further evidence of their dormancy is the lack of food in the digestive tubes of the animals taken after the land migration has begun.

The emergence from hibernation in the spring occurs at about the time the surface temperature of the water reaches 15°. The date differs with the year and with the locality. In 1950, a typical year, early March was very cold and snowy. On March 19th, when the air temperature was 13°, the snow at Whately Glen was 0.6 m. deep on the northwest slope of the pond. Only the spring fed area at the northeastern part of the pond was free of snow; a few grass hummocks rose above the snow. The water temperature in the ice free area was 6° A week later the air temperature had risen to 17° and much of the snow and ice had melted. The water temperature at the northeastern end of the pond was 10°. About 20 hydrometrids, which were crawling on the grass roots and on the water-filled depressions between them, were taken. That they had not yet started to eat was indicated by the completely empty digestive systems of the five that were killed immediately and dissected. On April 1st, the air temperature was 15° and the water, 13°. Hydrometrids were near the shore but none was on the water. April fourth was a warm day with the air temperature 21° and the surface water near the shore, 17°. Hydrometrids were both on the water and on the vegetation near it. The five insects examined had not eaten. On April 8th, when the air temperature was 19° and the water temperature 16°, most of the hydrometrids seen were on the water; of the ten examined, nine had partly filled digestive tracts.

In the same year, open water appeared later at Lithia. On March 19th the pond here was completely covered with snow and ice. On the 25th, a sunny day with an air temperature of 14°, the ice had melted but the water temperature was only 3° and there were snow banks on the south and west slopes. No hydrometrids were found. Ten days later, on April 4th the water temperature was 15°, the air temperature 21° and dozens of hydrometrids were stalking on the water. Three of the ten examined had eaten recently.

The earliest spring collection of *Hydrometra* was March 16, 1949, when two wingless females were found on the water at Whately. This was a rather warm day with an air temperature of 17° and the water in the place where the insects were taken was 13°. However, there were large snow patches on the ground and most of the pond was ice-covered.

In 1951, warm spring weather was late. On April 3rd, the pond at Whately was almost completely covered with ice and the snow cover was between 0.5 and 1.0 m. deep. Hydrometrids were not collected until April 20th.

Reproduction

The mating of *Hydrometra* can be observed in the laboratory or in the field in the spring and summer. Typically, as he approaches the female, the male protracts the eighth abdominal segment to lower the genital capsule. He may come toward her from any direction but usually he approaches from the side and, swinging his body parallel to hers, the male mounts the female and holds her prothorax with one or both of his forelegs. The seventh abdominal processes rest on the eighth tergite of the female; the other pregenital segments do not touch. The eighth segment of the male projects obliquely ventrad and the ninth segment (genital capsule) is directly under the ninth segment of the female. The phallobase extends to the vulva while the aedeagus with its process are within the female reproductive tract. The short parameres do not make contact with the female.

During copulation, the female walks elevating and depressing her body, carrying the male on her back. Not infrequently she feeds in the process. The male remains mounted on the female for as long as 15 minutes but actual mating seems to last not more than six minutes. After the male releases the female, she may push him aside with her middle and hind legs.

Males were never observed to copulate with a second female immediately after a successful mating. However, if the male failed to mate with the first female he approached, he usually sought another.

The preoviposition time in *Hydrometra martini* is variable; in the first spring generation, this period lasted between nine and seventeen days for ten animals brought into the laboratory on June 29, 1949, as fifth instar nymphs. As these animals molted to the adult stage, each was placed in a 3-inch stender dish with a sexually mature male. Each dish was examined every other day; the eggs were counted and removed. In the observation period, five males died and were replaced. There was no apparent pattern of numbers of eggs laid. The greatest number laid by any individual in the two-day period was 14 while the average number laid in two days varied between 3.5 and 6.2. The longest-lived individual in this series continued to lay eggs until September 5th, and died on September 12th. Between August 15th and September 9th, she laid 72 more eggs making a total of 161. An animal which lived until September 2, laid a total of 118 and another laid 121 before she died on September 3rd.

Fifteen females reared from fifth-instar nymphs collected later in the same summer, matured more rapidly. This group was collected on July 21st and completed the final molt between that date and July 26th. The average preoviposition time was 8 days, the minimum 7 days and the maximum 10 days.

In the field, females which undergo their final molts at the end of the summer or in the early fall seem ordinarily not to lay eggs until the following spring. However, young females brought into the laboratory in September and October of 1950 began to lay eggs after November 20th. The average preoviposition time of six females collected in September was 69 days with a variation of from 59 to 81 days; that of five females taken in October was 65 days with a range of 53 to 73 days. Females collected from hibernacula in mid-December of the same year laid eggs about four weeks later.

Hydrometrids collected in the early spring mature more rapidly than those brought into the laboratory in the fall and winter. A group of five animals taken at Whately, Massachusetts on March 26, laid their first eggs between April 13th and April 18th; the average interval between collection and egg laying was 19 days. Ten others taken at Whately two weeks later began laying eggs within 5 to 13 days with an average of about 10 days. All of the females brought in after April 25th of that year laid eggs within a day or two of their collection.

Because observations of the previous year had indicated that *Hydrometra* mates before going into hibernation, all of the females collected for this study in 1950 were isolated. Since the eggs of all but two females (these were of the group collected on March 26th) were fertile, copulation must occur normally in the early fall when the females have small ovaries with no well-developed eggs.

The egg laying process is an extremely simple one. In the laboratory, a female walks about the container slowly, dragging or touching her abdomen to the floor. Then she stops and raises the anterior part of her body. Her front legs are almost straight, her middle legs extend laterad and her hind legs are bent at the femorotibial junction. After the female has tapped the supporting surface with her abdomen for two or three minutes, a small drop of fluid is expelled from the genital opening.

The base of the egg follows the fluid, and as the egg emerges, the female lifts her body. In so doing, she draws the egg perpendicular to the support. The whole process may be completed in four to five minutes although it may take as long as 15 minutes.

If the hydrometrid is disturbed in oviposition, she moves to another place and starts the process anew. Some may choose a vertical instead of a horizontal support. In this case, the female with her head downward, holds her body parallel to this surface.

Discussion

The measured gait of *Hydrometra* was noted by Arrow (1895) and by numerous later authors (Kirkaldy, 1899; Martin, 1900; Bueno, 1905; Weber, 1930; Jordan, 1931). That the movement of the legs is principally on a horizontal plane was mentioned by Weber (1930). This is correlated with the articulation of the coxae deep within the supracoxal cavities which was mentioned previously (pp. 614-15). The front and middle legs can swing in a wide arc but the hind legs with its coxal process articulating with the posterior part of the supracoxal wall, is limited in its forward movement.

The elevation and depression of the body by a curious swinging movement which is characteristic of hydrometrids was reported by Jordan (1931). No function can be ascribed to this behavior pattern, but the equally characteristic grooming movements, which Jordan also noted, seem to be important in the animals in keeping their appendages dry. Both Jordan and Weber believed that waxy or oily secretions distributed by this action, as well as the fine setae, help in making the body surface hydrofuge. The distribution of weight of this slender-bodied insect on its six widely separated legs and the hydrofuge nature of the exoskeleton (especially of the tarsi) are sufficient adaptations to enable it to walk on the surface film.

Flight in gerrids in the laboratory has been reported by Wilke (1908), who found that although recently caught gerrids did not fly, those which had been kept in tight containers for about ten hours flew away as soon as they were released. From observations on gerrids in the field, he concluded that they flew only at night since pools, in which there had been none in the evening, would have a large population the next morning. Tevrovsky (1920), also reporting on gerrids, observed that flight also occurs during the day.

Flight in *Hydrometra* is not reported in the literature. Beamer (1949), however, found that *Hydrometra* as well as many other water bugs were attracted to lights. A South American species, *Hydrometra mensor,* was described by White from a specimen labeled "Manaos on board at light VIII, 1875" (Hungerford and Evans, 1934).

An additional record of attraction to light is that of Hungerford and Spangler (1952) who collected two first-instar and one fourth-instar nymphs of *H. martini* in a light trap set at the surface of Nichol's Bog, Cheboygan County, Michigan, on the night of August 11, 1952.

Other investigators have mentioned many kinds of insects which serve as food for *Hydrometra. Hydrometra stagnorum* has been reported to feed on springtails (Arrow, 1895) and on dead or nearly dead insects such as dipterans and mayflies (Ekblom, 1926), and dead flies (Jordan, 1931). Martin (1900) and Bueno (1905) emphasized the use of aerial insects caught in the surface film as food by *H. martini,* while Hungerford (1917, 1920) observed that *Hydrometra* eats a great variety of animals in the field. These include: mosquito wigglers and pupae, emerging midges, nymphals corixids, ostracods and small terrestrial insects. Riley (1918) fed hydrometrids with entomostracans in the laboratory.

The methods by which *Hydrometra* obtains these food animals are typical of the predacious Hemiptera which lack raptorial forelegs. The securing and holding of prey with the mandibular stylets and the probing and sucking by the maxillae were mentioned specifically by Hungerford (1920) for this genus. The carrying of small insects on the beak was seen by Arrow (1895) and Ekblom (1926) as well as by Hungerford (1920). Although more than one hydrometrid was never seen to feed on a single victim in the field in the present study, this sharing of an individual food insect has been cited for both *Hydrometra stagnorum* (Ekblom, 1926) and *H. martini* (Martin, 1900).

Because *Hydrometra* lacks a separated salivary channel in the maxillary tube, the use of saliva in the feeding process has been questioned (Ekblom, 1926; Weber, 1930). However, the evidence seems overwhelming that saliva is injected by hydrometrids into their victims and that it is effective in paralyzing them. Bueno (1905) also thought that living victims were paralyzed by hydrometrids, although according to Baptist (1941) the saliva of Hemiptera is principally digestive in function and only secondarily toxic.

The hard exoskeletons of the adults seems to render them invulnerable to other insects of the same or larger sizes. This is probably the advantage of the fusion of body parts and the lack of thin intersegmental membranes. Cannibalism was never seen in adults nor were adults observed to be eaten by other animals in the field although large lycosids and gerrids roam the surface film with them and *Ranatra, Dytiscus* and other large carnivorous insects lurk beneath it.

When *Hydrometra* leaves the water to hibernate, feeding ceases. Both *H. martini* and *H. stagnorum* have long been known to hibernate as adults in the decaying vegetation around the banks of the waters which they inhabit. This was reported for *H. stagnorum* by Wesenburg-Lund (1913), Stichel (1926), Jordan (1931) and Schumann (1934). Schumann also found a wingless pair in the woods far from water. Jaczewski (1936) mentioned finding very few nymphs of *H. aegyptia* in collections made from September to March in Egypt and concluded that here, as well as in Central Europe, most *Hydrometra* winter as adults. Both Martin (1900) and Hungerford (1920) saw *Hydrometra martini* coming out of hibernation during the first warm days of spring. Bueno (1905) found hundreds in May at Staten Island.

Although female hydrometrids are able to lay fertile eggs prior to mating in the spring, proof that they do so in nature is lacking. Jordan (1931) observed that *H. stagnorum* and *H. gracilenta* mate at the end of April and early May in Germany; he did not mention whether egg laying preceded copulation in these species. Martin (1900) who worked on *Hydrometra* at Ithaca, New York, collected females which were laying eggs as early as May 1st, but whether or not these animals had mated was not reported. Bueno (1905) bred virgin females with captured males on May 26th, and found that they had deposited eggs two or three days later.

The first report of mating in *Hydrometra* is that by Palumba (1891). According to this account, the female is pursued by as many as eight males which battle ruthlessly. The victor mates with the female, but dies a few days later; the female lays her eggs and then dies. This process of selection, which Palumba believed to lead to the strengthening of the species, has not been confirmed.

Both Ekblom (1926) and Jordan (1931) included accounts of copulation of *H. stagnorum*. Mating pairs were never seen on the surface film by Ekblom but Jordan mentioned the depression of the female by the added weight of the male. They both found that sometimes, immediately after mating with a female, a male would mate again with the same or another female. These two authors agreed in finding the duration of copulation highly variable.

In the northern part of the United States, the egg laying period, like the mating period, is continuous from April through August. This is the case in New York (Martin, 1900; Bueno, 1905) and Kansas (Hungerford, 1920) as well as in Michigan and Massachusetts, as shown in the present study. Jordan (1931), working in Germany, found that the egg-laying periods for *H. stagnorum* and *H. gracilenta* last for at least six weeks in April and May.

The length of the egg-laying period and the number of eggs laid by a single *Hydrometra* have been recorded most completely by Hungerford (1920). One female which had molted to the adult stage in the laboratory on July 25th, had mated and laid 28 eggs by August 4th. She had deposited a total of 173 eggs by August 31st, and continued to lay eggs after that date. In part of the period, she averaged 7.8 eggs per day and on one day, laid 11. This indicates a production of an egg by almost every ovariole each day.

The only reports on numbers of eggs laid by European species are those of Jordan (1931) who found that average number of eggs laid by *H. stagnorum* was 47 and that a single *H. gracilenta* deposited 53 eggs.

The simple expulsion of the egg by the female and its attachment by a sticky disc to a support has been observed by other investigators for several species: *H. martini* by Martin (1900) and Hungerford (1920), *H. stagnorum* and *H. gracilenta* by Jordan (1931) and *H. vittata* (probably *H. albolineata*) by Takahashi (1921).

NUMBER OF GENERATIONS AND LONGEVITY

There seem to be three full generations and a partial fourth generation of *Hydrometra martini* in both Michigan and Massachusetts. The over-wintering generation begins reproductive activity in late April or early May in Massachusetts. Some of these individuals live and lay eggs as late as the second week of July. In both places, the first nymphs of the spring generation molt to the adult state about June 20th. In the laboratory and probably in the field, these females begin to lay eggs in about ten days and live, laying eggs, until nearly the end of the summer. The first offspring of this generation, arising from eggs laid about July 1st, are the summer generation. They complete the nymphal instars and reach their final molt in three to four weeks. After a preoviposition period of a week to ten days, the females begin to lay eggs. Eggs of the summer generation, then appears as early as August 1st and they are laid continuously until late summer. Some animals arising from this generation may also reproduce in the same season, and therefore give rise to the fourth generation. Most of them, however, do not lay eggs until the following spring but they do mate before going into hibernation.

Because of the long life and extended oviposition period of the females, members of various generations are sexually active simultaneously during the summer. In the laboratory the animals that lived longest were those of the summer generation; they lived from late August until the following June or July, having attained an age of about ten months.

Discussion of Longevity and Number of Generations

The record for the longest life in *Hydrometra martini* is that reported by Bueno (1905) who found that an individual taken in May overwintered and lived until the following August. Neither in the present study nor in others in the literature has a span longer than from September or October to the following June or July been reported.

Bueno (1905) gave an average life cycle of 25 to 35 days and three to five broods per summer in Staten Island, New York. Martin (1900) implied that there were several generations in Ithaca, New York. In Kansas and farther south, the number of generations may well be more than five. Hungerford (1920) reported an optimum life cycle of 15 days from egg to egg although the average in the summer was about 21 days. With reproductive activity beginning earlier in the year and continuing until fall, there are conceivably as many as eight or nine generations in a season.

Workers in northern Europe (Wesenberg-Lund, 1913; Ekblom, 1926) found only one generation per year of *Hydrometra stagnorum* which Ekblom found to reach the adult state at the end of July but in England according to Arrow (1895) and in Germany according to Jordan (1931) there are two broods. Jordan supported his field observations with laboratory rearings; one generation matured in late June and the other, the overwintering generation, approximately seven weeks later.

The number of generations produced in different areas varies greatly. Temperature probably is the factor responsible for reproductive activity in *Hydrometra.*

THE EGG

Appearance

The spindle-shaped and beautifully sculptured egg of *Hydrometra martini* is comparatively large, about 2.0 mm. long and 0.2 to 0.28 mm. wide. The egg shell or chorion consists of two layers. The leathery outer exochorion protects the embryo and is responsible for the shape and surface pattern of the egg (fig. 57). The central portion of the inner layer, or endochorion, is a delicate sheath which surrounds the embryo proper. From it extends two slender projections: a spicule leading through the stalk into the basal attachment disk and a delicate tube terminating in the micropyle at the free end of the egg (fig. 58).

The scuplturing of the exochorion indicates the intricate arrangement of the air spaces within it. Each of the larger divisions, the basis of which abut on the micropylar tubule, is subdivided into a myriad of minute alveoli. Their outer surfaces make a diamond pattern on the exochorion. A cross section of this region shows the arrangement of these compartments (fig. 60), and the proximal part of the basal stalk has a similar pattern. Here large air chambers surround the spicule of the endochorion. The distal part of the stalk, adjoining the gummy basal disk, consists of simple and rather transparent air cells which lack internal partitions (fig. 59).

The sculptured pattern of the wider middle area gradually merges with that of the two ends. In most of the eggs the sculpturing of that part consists of crests separated by furrows extending from one end of the central area to the other. In some of the less typical eggs, transverse ridges connect the longitudinal ones making a more or less extensive network. The raised surfaces are spongy with a vast number of minute air spaces. In a few eggs a hexagonal pattern takes the place of longitudinal grooves.

All of the air-filled spaces in the exochorion make the hydrometrid egg look opaque and give it excellent flotation. Dry eggs dropped in water rest on the surface film or float just beneath it. Those which are submerged, so that some of the air is replaced by water, soon sink and the outer chorion becomes translucent.

When they are laid, hydrometrid eggs are pearly white. They darken quickly if dampened either by being attached to wet surfaces or by being exposed to moist air. Within five minutes they turn to a light tan color and fifteen minutes later they are brown. No further color change occurs during the development of the embryo. On the other hand, eggs that are completely submerged in water immediately after they are laid, darken slowly. After 24 hours they are only slightly colored and within the next few days, they become cream colored.

Eggs of *Hydrometra martini* vary between 1.8 and 2.2 mm. long and between 0.20 and 0.22 mm. wide when they are laid. The length does not change but the width increases notably during development. During the third day of incubation (at 25°), the eggs expand to their maximum diameters; some reach 0.28, others only 0.25 mm. The size of the egg remains constant from this time until it hatches.

Development

Some features in the development of the embryo can be seen in living hydrometrid eggs and can be followed only if the eggs are moist enough to be translucent. Eggs for this study were incubated at 25° in stender dishes lined with moist towelling paper.

The first change that can be seen as the living embryo develops is the appearance of small red eye spots on the third day after the egg is laid. There are near the posterior end of the egg where they remain for four to eight hours (fig. 61). During the next two hours blastokinesis or inversion of the embryo, occurs and the eyes shift to the apical part of the egg (figs. 63 and 64). The eyes remain in this position, enlarging rather gradually for the next five days (figs. 65 through 69). The egg burster, a conspicuous black cross between the eyes, becomes apparent on the eighth day. On the eighth and ninth days, the margins of the embryonic cuticle surrounding the labrum begin to darken (figs. 66 and 67). By the eleventh day, the labrum is clearly outlined and the appendages of the head and thorax are pigmented enough to be seen (fig. 69). The antennae and first and second pairs of legs extend posteriorly and then loop upwards on the embryo's left side before they continue backward. The antennae and beak lie ventral to the legs. The claws of the first and second pairs of legs are close together posterior to the tips of the antennae. The metathoracic legs extend caudad almost to the end of the abdomen, and then bend upward on the opposite side so that the claws are lateral.

Some of the eggs incubated at 25° hatch on the eleventh day, some on the thirteenth and a few on the fourteenth, but the highest percentage hatch on the twelfth day of incubation. Of 68 eggs laid on July 22, 1950, by wingless hydrometrids in the laboratory, about 70 per cent hatched on the twelfth day and 17 per cent on the thirteenth day of incubation. Eleven other eggs laid on July 22nd failed to hatch. Of these, five did not show any signs of development and may have been infertile. Three failed to complete blastokinesis, and in each the eyes and egg burster developed in abnormal positions. Three other embryos, which had appeared to be normal, turned black without beginning to emerge.

Of the 50 eggs collected in the field on July 28 and July 30, 1950, only three failed to develop. The others hatched between July 31st and August 9th.

Hatching

The hatching of a hydrometrid egg follows a fixed pattern. Table 1 is a time schedule of the procedure in a series of five nymphs which hatched on the morning of August 5, 1949. These eggs of unwinged adults were laid in the laboratory on July 24th and were kept on moist towelling paper. The process of eclosion is essentially the same in eggs which are submerged or rest on the surface film.

The young hydrometrid begins the hatching process by sucking in the fluid within the egg shell. With the increased pressure from the enlarging animal, the egg burster moves against the chorion and splits it. The vertical part of the egg burster is knifelike, hard

TABLE 1.—*Intervals of time in minutes taken in Eclosion of 5 Hydrometra martini nymphs on August 5, 1949.*

Activity	Intervals of time in minutes after first split of chorion				
"Egg burster" exposed	1	1	1	1	2
Inner margin of eye exposed	3	2	4	2	1
Half of eye exposed	2	2	2	1	2
Eyes entirely exposed	6	5	4	4	7
Labrum freed	1	1	2	1	1
Thorax entirely exposed	1	3	1		
Exuviae split	2	3	2	3	4
Head and thorax out of exuviae	2	3	3	3	1
1st leg freed of exuviae	1				3
2nd and 3rd leg free	2	2	1	1	1
Antennae free of exuviae	2	1	1	1	
Legs on support	1	2	1	2	2
Abdomen lifted from exuviae	3	2	1	2	2

and slightly raised from the surface of the rest of the embryonic cuticle. The nymph pushes its head through the slit in the egg shell until the inner margins of its eyes begin to show. It continues sucking and swallowing the fluid still surrounding it within the chorion. Within six minutes of the time the chorion splits, the eyes are half exposed (fig. 70). Then it is completely quiet for four to seven minutes. As air replaces the fluid within the chorion, the continued sucking brings bubbles of air into the digestive system. Within the next minute the nymph pushes its head outward, frees its labrum and thrusts its thorax out of the chorion (figs. 71, 72, 73). It then continues to extend its body from the egg shell by movements in a dorsoventral plane. As the nymph arches its body, it lifts its head, holding its antennae and beak rigid (fig. 74). Straightening the body, it bends its head down (fig. 75), pushes the thorax out, unfolds and draws out its legs. The tarsal segments and the tips of the antennae and beak as well as the end of the abdomen remain in the chorion and support the rest of the body. With its body perpendicular to the egg shell, the nymph rests and completes the process of filling its entire abdomen with air.

By muscular contractions that start in the metathorax and pass forward to the base of the head, the nymph now increases the pressure on the embryonic exuviae and these break along the conspicuous dark sutures of the head (fig. 76). The animal pushes its head out of the embryonic cuticle rapidly, the egg burster and the membrane attached to it pass backward over the thorax, the bases of the legs and the abdomen, (figs. 77 and 78) and within three minutes frees its legs. During this process, the femora bend at a number of points as well as at the articulations. After it extricates its last leg, the nymph pulls the antennae and labium out. The tip of the abdomen remains for a short time within the molted skin and within the chorion. This anchor gives support to the nymph while it struggles to bring its feet into contact with a surface. When the animal begins to walk, it finally pulls the abdomen free.

The hatching process takes between 20 and 30 minutes. If eclosion is prolonged or if any part of it is out of proper sequence, the nymph dies. Death may occur at the beginning of hatching or when the nymph has started to molt its embryonic cuticle. But the greatest number of fatalities comes as the nymphs free themselves from the chorion. The legs are hopelessly caught if they do not molt before the labium and antennae do.

A hydrometrid hatching from an egg floating on or immediately under the surface of the water lifts its head above the surface film so that it swallows air. The chorion, lying parallel to the water, acts as a platform until the nymph can lower its legs to the surface film and walk away.

When a nymph emerges from a completely submerged egg, it sucks in water instead of air to distend the digestive system. A nymph can live only an hour under water; after that its exoskeleton becomes permeable and the tissues become hypotonic. A nymph which approaches the surface with one side uppermost cannot lift its body for most of its movement is parallel to the film.

Any nymph which maneuvers in such a way that its dorsum comes in contact with the surface film quickly raises itself out of the water. For an instant it lies with its body outstretched, the first and second pairs of legs extending diagonally forward, its hind legs stretching parallel to the abdomen. First it lifts its head and antennae out of the water, next its thorax, then its first and second pairs of legs and finally its abdomen and hind legs. Then it dries its appendages by lifting them in the air and by rubbing the various parts together.

Discussion of the Egg Stage

The eggs of *Hydrometra* have been described and illustrated by a number of workers. The earliest description of a hydrometrid egg was that published in 1855 by Leuckart whose careful drawing showed the basal shaft with the attachment disc as well as the micropyle. Some of the information from the literature on the eggs of three species of *Hydrometra* is summarized in Table 2.

The eggs of *Hydrometra stagnorum* are less elongate but otherwise similar to those of *H. martini.* Some illustrations in the litera-

TABLE 2.—*Summary of information on hydrometrid eggs in the literature*

Species	Author	Length in mm	Width	Color
H. stagnorum	Brocher ('11).......	1+	....	grayish, opaque
	Jordan ('31)........	1.66	0.25	white when laid; yellow brown later
	Schumann ('34).....	....	....	dark brown
H. gracilenta..	Jordan ('31)........	1.5	0.23	yellow
H. martini....	Martin ('00)........	2.00	....	....
	Hungerford ('20)....	2.07	0.277	white when laid; brown later

ture, like that of Leuckart (1885), show a basal shaft only slightly shorter than that of *H. martini,* but others (Tevrovsky, 1920; Schumann, 1934) indicate a short base. Brocher (1911) pictured and described an egg in which the basal air cells are broken and referred to the egg as being mobile as the clapper of a bell. This part of his description, as well as his figure showing longitudinal grooves within an oval outline, were criticized by Jordan (1931). The illustration of the egg by Jordan shows deep grooves arranged longitudinally and oval granules at either pole. Schumann (1934) indicated grooves extending from one end of the egg to the other, and a little papilla near the micropyle. Tevrovsky (1920) included two drawings of the egg of *H. stagnorum,* one of its external appearance and one as it looked after being cleared in cedar wood oil. The latter shows the micropylar tube and the basal shaft, which in this drawing is very short. The egg of *H. gracilenta,* which was described by Jordan (1931), was not illustrated.

The drawing of the egg of *H. martini* by Martin (1900) is well known because it has been used in textbooks (Comstock, 1936; Wesenburg-Lund, 1934). As he mentioned in his text, Martin overemphasized the hexagonal pattern at the expense of the longitudinal furrows. Hungerford (1920) showed these clearly in his figure. His photographs of hydrometrid eggs with sprouting cattail seeds showed their similarity to one another.

The considerable variation of colors mentioned in the descriptions of the eggs of each species correlates with the actual differences in eggs of a large series. Eggs of *H. martini,* which are grayish and iridescent when they are dry, become a dark or light brown when they are wet. That newly laid eggs are white and that they darken quickly was mentioned by Hungerford (1920) and by Jordan (1931).

Poisson (1924) stated that eggs of a variety of water bugs are white when they are laid and that a secretion of the reproductive tract is responsible for their darkening. This is certainly true of the eggs of *H. martini.* The change in color must be the result of an interaction of the secreted substance with air and water since all three are necessary for the color. Eggs dissected from the female do not darken, those which are submerged as soon as they are laid darken slowly and those kept dry do not change color at all.

Hydrometra stagnorum, as well as *H. martini,* lays eggs on any convenient object. Jordan listed a large number of plants on which he found eggs and both he and Schumann (1934) described eggs being laid on the sides of containers in the laboratory. Bueno (1905) found the aquarium in which he kept two female hydrometrids studded with eggs by the end of the summer. Both Martin (1900) and Hungerford (1919) said that the females placed eggs on any firm object. Jordan (1931) found the eggs always laid high above the water surface on dry leaves but he did not discover any on *Nymphaea* or on emergent reeds. Brocher (1911) however collected hydrometrid eggs on floating vegetation and debris; all of these were covered with water or resting on its surface. Takahashi (1921) working with a Japanese species stated that these insects deposited their eggs on grass or twigs on the water, but that the eggs were often found under water.

The length of the developmental period varies considerably. According to Arrow (1895), eggs of *H. stagnorum* laid on May 23, hatched three weeks later. Schumann (1934), working with this species, found nymphs on June 11th which had hatched from eggs laid on May 29th. Martin (1900) gave 17 days as the developmental period for *H. martini.* According to Hungerford (1920), eggs laid in May took 23 days to hatch while those laid in July hatched after only seven days. Bueno (1905) noted that embryonic development took nine to ten days in midsummer.

Hungerford (1920) in Kansas in July and Bueno (1905) on Staten Island, New York in summer, found the incubation period to be less than 11 days. The temperatures probably were higher than 25°. The incubation periods of 11 to 13 days were observed in the present study.

Of the numerous authors who have worked with *Hydrometra,* only Hungerford (1920) has discussed the hatching process in detail. He described the bulging of the head with the eyes and the egg burster appearing, the pushing of the body at right angles to the shell followed by the breaking and shedding of the embryonic cuticle and finally the unfolding of the appendages. He provided three figures—two of the emergence of the head and the other of the exuviae.

Brocher (1911), who referred to the role of the egg burster and the postnatal molt in *H. stagnorum*, included a drawing of the shed cuticular skin caught in the opening of the egg shell. Schumann (1934) observed a nymph of this species escape from its shell and mentioned that the process took 5 minutes. His figures are of the late stages of hatching. In each, the egg is on its side and the emerging nymph is twisted with its head close to the base of the egg. With *H. martini,* this does not occur. Schumann also showed a torn opening in chorion rather than a simple slit which has been described by other investigators.

Takahashi (1921) described the hatching of *Hydrometra vittata* (probably = *H. albolineata*) from submerged eggs. This species seems to be better adapted to life underwater than *H. martini* for none of the animals he observed died underwater or while emerging from it. The nymphs that hatched underwater walked or swam until they came to rest with their backs against the surface film. A nymph in this position bent its head and abdomen until it had lifted its head above the water. Then the thorax, first and second pairs of legs and finally its hind legs and abdomen were raised. This procedure is essentially the same as that followed by the successful nymphs of *Hydrometra martini.*

THE ACTIVITIES AND STRUCTURE OF THE NYMPH

Activities of Nymphs

The bright red eyes of the hatching hydrometrid nymph are conspicuously set off by the paleness and delicate green of its head and body. Its legs and antennae are transparent. The abdomen is expanded and through the translucent body wall the anterior part of the ventriculus can be seen filled with air. At this time the nymph is 1.5 mm. long. If the nymph is undisturbed, it will remain close to the egg shell from which it hatched. However, if it is disturbed, it can easily walk or run. Within 15 minutes after hatching, the abdomen contracts, forcing the air from the gut of the abdominal region into that of the second and third thoracic segments. The contracted abdomen appears a darker green and, by this time, there is a darkening of the legs and head. The body-length decreases to about 1.2 mm.

Before the nymph is an hour old, it lowers its rostrum to the moist substratum to obtain water. The stylets extend beyond the tip of the last labial segment and water is pumped up through them by the muscles of the head. The fluid passes into the pharynx and through the narrow esophagus into the ventriculus. The first water that enters the stomach seems to absorb the air there so that after the animal has been drinking for ten minutes or so, the size of the air bubble is greatly reduced. Peristaltic contractions of the wall of the gut, some of which start anteriorly and others, posteriorly, churn the contents.

When food is available, the nymph may begin to eat about an hour and a half after it has hatched. Some nymphs observed in the laboratory, however, did not feed for as long as 12 hours after hatching although food was available. When the nymphs begin to eat, the juices of the prey pour into the ventriculus and mix with the water there. After 24 hours, the curved posterior ventriculus which lies in the abdominal segments is distended with dark residual substances. An animal to which food and water is available stretches out to about 1.6 mm., nearly its maximum length.

The locomotion and feeding of first instar nymphs, as well as those of the older nymphs, are essentially those of the adults. They walk on the surface film, on damp earth or on vegetation, their antennae swaying from side to side. The nymphs continually groom their appendages and display the up-and-down movement characteristic of the adults. The flexibility and longitudinal intersegmental muscles of the abdomen make possible its curvature; nymphs often carry the posterior end of the abdomen arched over the body.

Submerged nymphs regain the surface rather quickly. Such an animal swims up so that its back makes contact with the surface film. By flexion of the head and prothorax, the anterior part of the body, including the forelegs, breaks through the film. The nymph then swims until it reaches an emerging leaf or other support, and crawls up on it. If no suitable substrate is available, the nymph arches its back, pushes its forelegs close together to raise the thorax until the middle legs and finally the hind legs and abdomen are elevated. Since hydrometrid nymphs are usually near land and hurry to it when they are disturbed, complete immersion probably is not a frequent occurrence.

In the laboratory, hydrometrids which are not isolated have a strong tendency toward cannibalism throughout their nymphal stadia. Hatching nymphs may be devoured by others which have emerged only a short time before. The victims are not necessarily the weaker animals; unwary nymphs of the fourth and fifth instars may be eaten by smaller nymphs. As with the adults, subsurface Entomostraca and other small animals form the chief food sources, but any sort of recently killed, or slow-moving, living insect may be used as food. Nymphs, carrying midges or ostracods with their beaks, walk on the surface film. In the present study, nymphs in the field were not seen to feed on organisms too large for them to carry, but in the laboratory they fed on flies such as *Musca* and *Drosophila.*

The interval between molts is highly variable even in series of animals kept under similar laboratory conditions. Nymphs hatching from eggs laid from June 28th to July 8th were isolated and kept in stender dishes lined with paper towelling. Each animal was fed one or more fruit flies a day and the exuviae were removed as they appeared. Under these conditions the intervals between molts varied between two and five days and the total length of the developmental period varied between twenty-two and thirty-two days.

As a nymph approaches the time of molting, it reaches nearly maximum length for its instar. The pigmentation of the cuticle, which gives a grayish cast to its exoskeleton, is lacking along the ecdysial line which extends in the mid-line from the metathorax anteriorly to the middle of the head where the ecdysial line forks and forms an arm on either side of the frontal region.

In the hour before molting, the nymph imbibes water more frequently than before. As the gut is distended, the nymph becomes a little longer than it had been previously and its entire body appears turgid. As water is taken in, small droplets of fluid are emitted through the anus. During the early part of the period, the animal walks about as much as usual. Then it becomes less active; if it is undisturbed it moves but little, although it continues to imbibe water.

The actual molting process takes place rather rapidly. For a minute or two, the nymph seems to be inactive. Then it resumes the intake of water and moves backward as it lowers its body. It pushes its hind legs into the substrate, arranging them so that they are parallel with the long axis of the abdomen. The middle legs are planted firmly at right angles with the body and the front legs extend forward.

When the nymph has placed its legs securely, it lifts its body and starts to suck air rather than water. As the sucking continues, the cuticle of the mesothorax begins to cleave. The head bends so much that the antennae almost touch the front legs. Air, in small bubbles, passes through the narrow esophagus into the ventriculus. With the distention of the digestive tube, the body lengthens. Alternate waves of contraction and dilation move up and down the body.

Since the head is bent ventrally, the prothorax is the most anterior part of the body at this time. With the posterior end close to the supporting surface, the long axis of the body forms an angle of about 45° with the substratum. As the body stretches upward the proximal parts of the legs emerge from the exuviae and begin outward movements, which help to pull the trunk forward. First the prothoracic and then the mesothoracic and metathoracic legs pull away from the exuviae. The legs touch the substrate; the antennae and finally the beak pull free. The nymph begins to walk away and the tip of the abdomen slides out from the molted skin.

The color of recently molted hydrometrids resembles that of the hatching nymphs. The body is pale green and the appendages are transparent. There is a touch of red on the pleura of the mesothorax, metathorax and, in the region of the spiracles, on the abdominal segments. The brownish contents of the posterior ventriculus make it distinct. The abdomen of fifth instar nymphs is marked by an opaque white middorsal stripe and two more translucent lateral lines. The lora are white and conspicuous.

Within thirty to forty-five minutes a recently molted nymph again begins to suck up water. When food is available, the nymphs begin to feed about two hours after they have molted.

Growth and Differentiation

Table 3 presents average measurements of head and body widths, leg, antennal, head, beak and total body lengths of adult and nymphal *Hydrometra*. Because of variations in the length of the abdomen during the nymphal stadia, total body lengths were measured at three times. Only the measurements taken at two days after molting are used in the following discussion of relative growth.

Relative growth rates using these data are shown in figures 1, 2 and 3. When they are plotted semilogarithmically against time in instars, the average measurements for body and head lengths fall nearly on straight lines, indicating constant rates of growth (fig. 1). The points representing measurements of head length, beak length, antennal length and body width fall on, or nearly on, straight lines when they are plotted logarithmically against

TABLE 3.—*Measurement of nymphal and adults (Hydrometra martini) in millimeters (average of 10 animals)*

Instar	Head		Antennal length	Leg length		
	Length	Width		1	2	3
1	0.5	0.17	1.4	1.2	1.3	1.8
2	0.7	0.18	1.8	1.7	1.8	2.4
3	1.0	0.2	2.2	2.1	2.4	3.3
4	1.3	0.22	2.7	3.2	3.6	4.6
5	2.0	0.3	3.4	3.6	4.5	6.3
Adult	2.8	0.4	4.0	5.2	5.8	8.4

Instar	Total body length (interval after hatching)			Beak length	Body width
	Immed.	1 hour	2 days		
1	1.5	1.2	1.6	0.7	0.27
2	2.1	1.5	2.3	0.9	0.32
3	3.0	2.3	3.3	1.1	0.36
4	4.2	3.1	4.6	1.5	0.41
5	6.2	5.1	6.5	1.8	0.48
Adult	10.0	....	....	2.2	0.50

total body length. Therefore each of these structures grows with each molt at a rate constant in relation to body length. The slopes of these lines, however, indicate that only head length increases at the same rate as body length. The beak grows at 67%, the antennae at 61%, each of the legs at about 87%, and the body width at 40% of total body length. Through the fourth instar (body length 4.6 mm.), the head width increases relatively slowly, that is, at about 25% of body length and after the third molt the rate approximates that of body and head lengths.

Data for relative growth of parts of the head are given in table 4 and plotted logarithmically on figure 4. The length of the eye increases at the slowest rate—53% of total head length. The slopes of the lines derived from data on preocular and postocular length show increase at rates of 108% and 97% of the head length, respectively.

The remarkable variation in the total body length during a nymphal stadium is the result of a partial telescoping of the abdominal segments and depends mainly upon the degree of distension of the digestive system (figs. 79 and 80). The minimum length, which is approximately that of the maximum in the previous instar, is reached about an hour after the molt is completed. At this time the air which filled the digestive tube during the molt has not been replaced by water or food. Later in the stadium, if the nymph does not maintain a distended gut by feeding frequently, the body length may decrease again. Of the nymphs taken

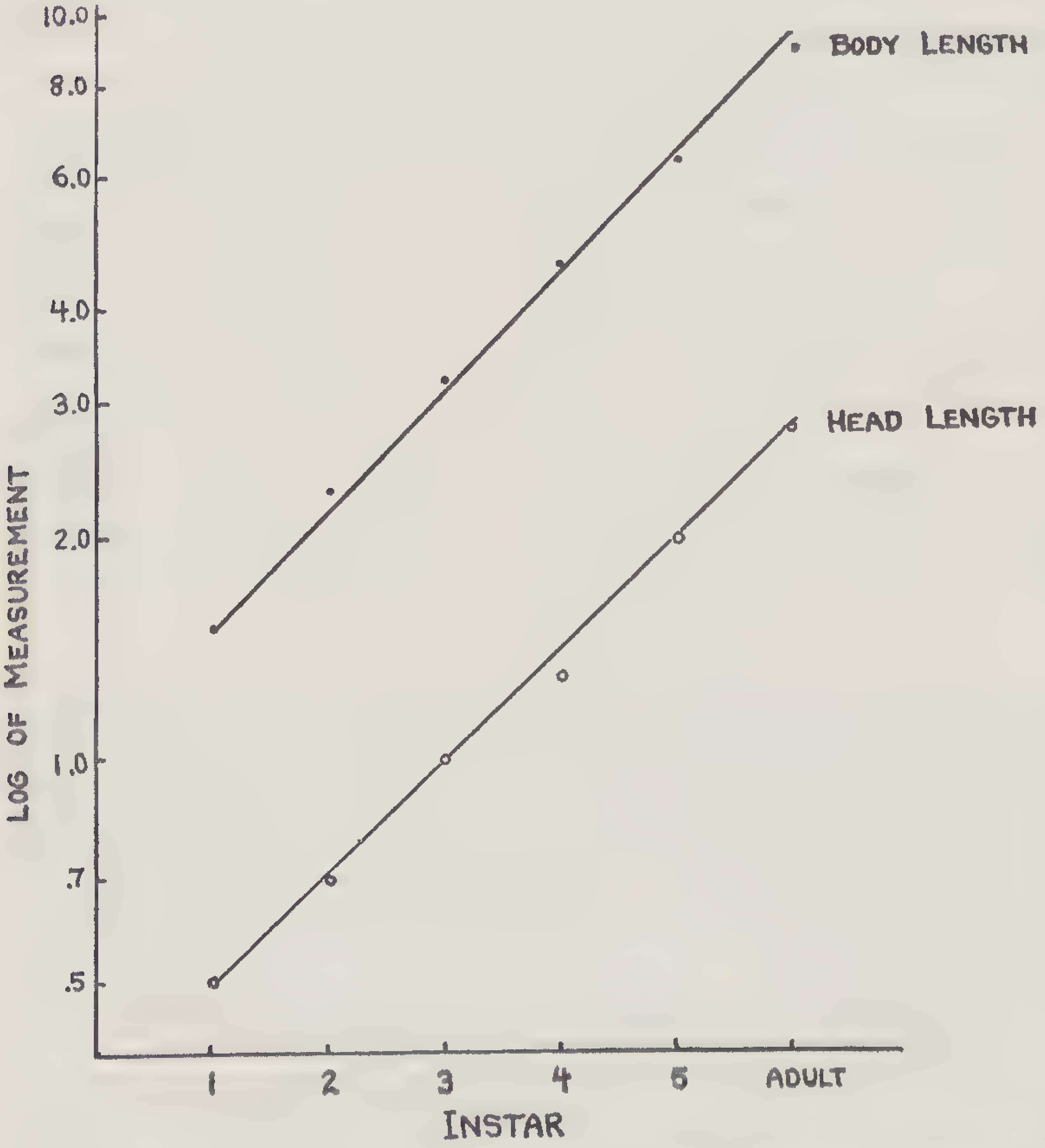

FIGURE 1. Head and body lengths plotted semilogarithmically against time in instars.

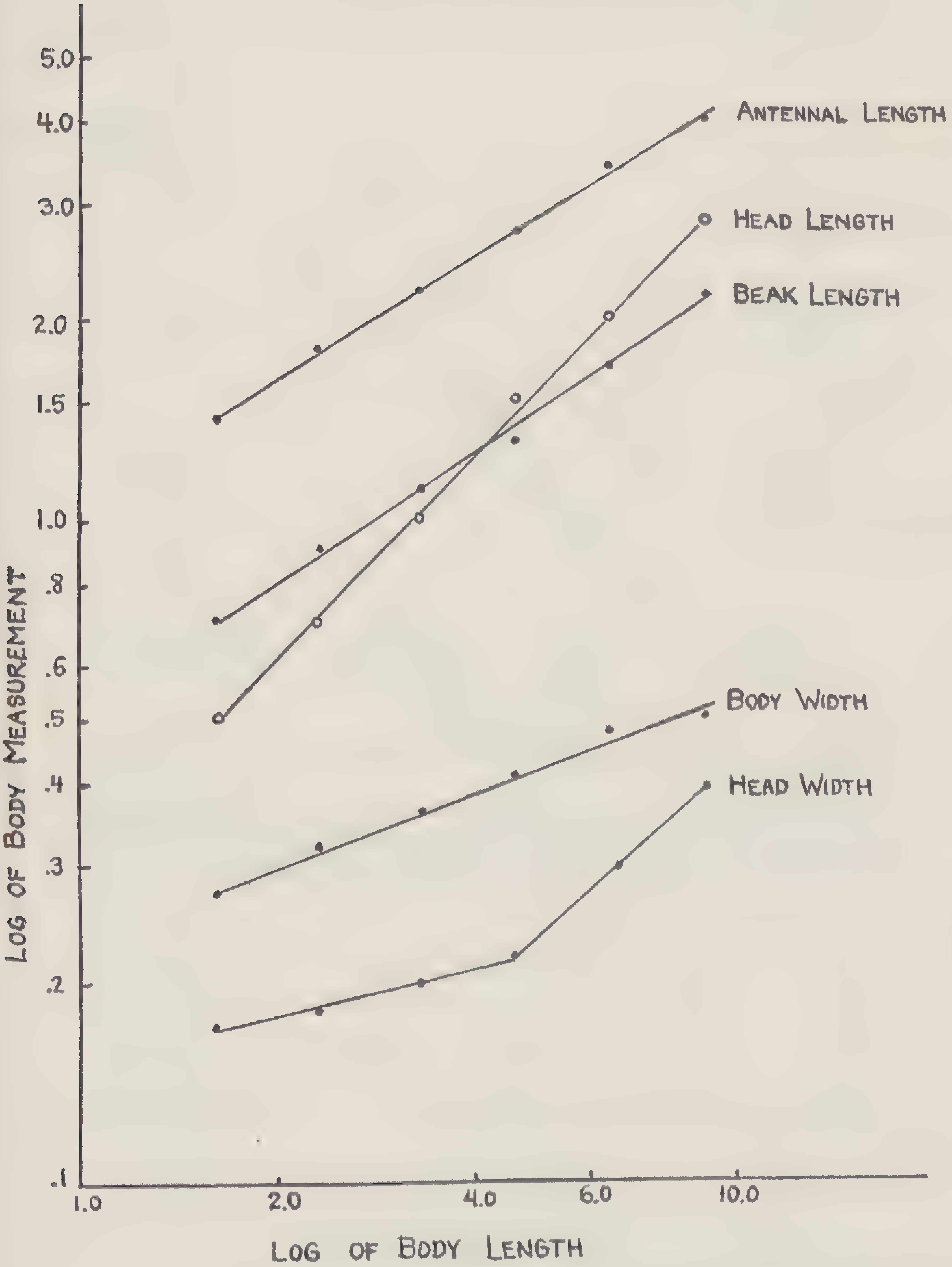

FIG. 2. Antennal length, beak length, head length and width, and body width plotted logarithmically against total body length.

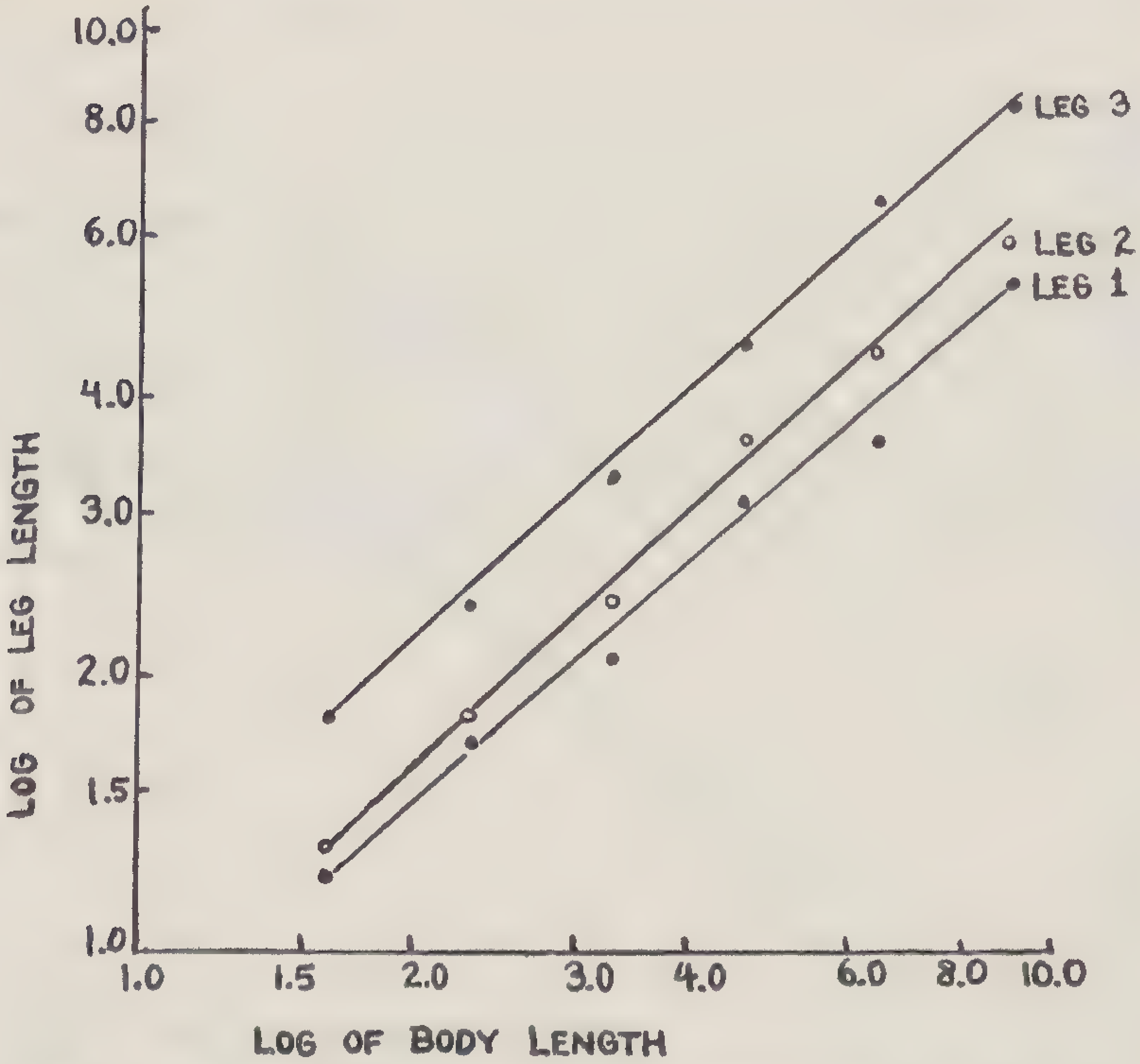

FIG. 3. Leg lengths plotted logarithmically against total body length.

TABLE 4.—*Comparisons of the sizes of the eye and the preocular and postocular portions of the head of Hydrometra martini nymphs and adults. Each figure represents an average for 10 animals in millimeters*

Instar	1	2	3	4	5	Adult
Preocular	0.25	0.35	0.53	0.71	1.19	1.65
Eye	0.08	0.1	0.125	0.14	0.17	0.2
Postocular	0.18	0.25	0.35	0.45	0.64	0.95
Total length	0.5	0.7	1.0	1.4	2.0	2.8

in the field, most had bodies of nearly maximum length. Food seems usually to be available to them there.

The nymphal head, like that of the adult, shows little differentiation into sclerites. The dorsal and lateral parts are more heavily sclerotized and more deeply pigmented than is the ventral part.

In the later instars the ventral surface becomes increasingly setose. The prominent setae, a pair near the posterior end of the head and a pair lateral to the anteclypeus, remain constant in position.

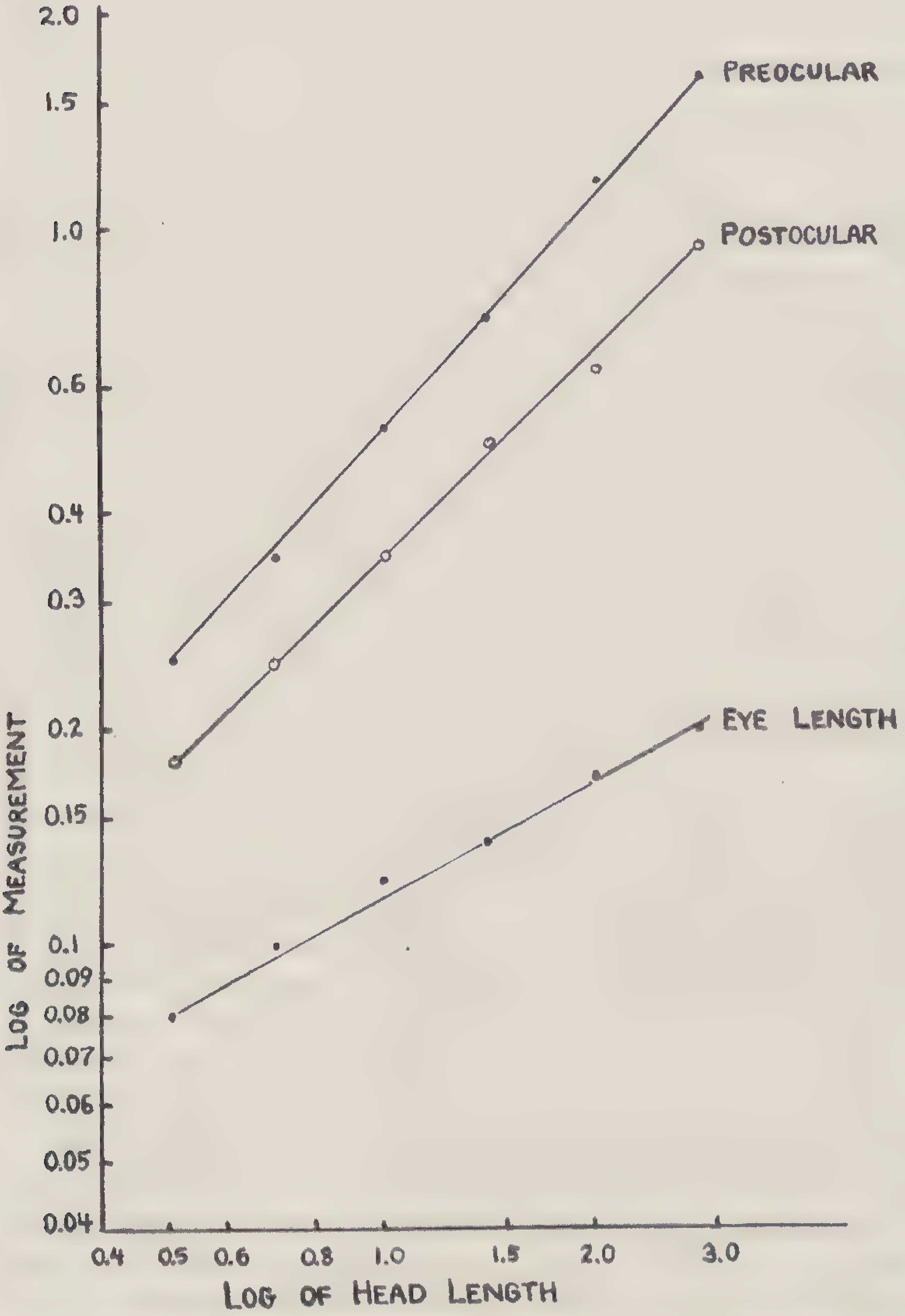

FIG. 4. Length of eye, preocular and postocular parts of the head plotted logarithmically against total head lengths.

In the first and second instars (figs. 82 and 85) the lora and maxillary plates are difficult to see. During the later stadia, the maxillary plates are white and conspicuous. Their ventral projections, the bucculae, appear in the fourth instar nymphs as narrow rims which are directed anteriorly (fig. 90). In the fifth instar these lobes are larger (fig. 99) but they do not cover the basal segments of the rostrum, until the final molt.

The thorax of the hydrometrid nymph shows much less fusion than that of the adult. In the first instar, the tergum of each segment is a rather flat broad plate (fig. 80). In the second instar the posterolateral angles of the mesotergum and metatergum are produced, indicating the formation of wing pads (fig. 84). The metatergum is much smaller than the mesotergum in the third instar nymphs (fig. 88). The wing pads of those individuals which will become macropterous are much more conspicuously developed than those of animals which will give rise to apterous adults (cf. figs. 107 and 108 with figs. 86 and 88). These differences are emphasized in the fourth and fifth instar nymphs. In the fourth instar nymphs, the wing pads reach the second abdominal segment; those of the metathorax are slightly longer than those of the mesothorax (figs. 109 and 110). The metathoracic wing pads of the fifth instar nymph extend to the middle of the third abdominal segment and the mesothoracic wing pads are slightly shorter (figs. 111 and 112). The mesothoracic wing anlage of the fourth instar nymphs which will become apterous adults extend over the bases of those of the metathorax (fig. 88). In the fifth instar the wing pads of the metathorax are not developed further, but those of the mesothorax extend posteriorly as broad lobes (figs. 98 and 99). The posterior lobe of the pronotum develops gradually; in the fourth instar it projects over the anterior margin of the mesonotum (fig. 90) and in the fifth over about a third of it (fig. 99).

The episternum and epimeron are of about the same size in the prothorax and mesothorax of the first instar (fig. 82). During the succeeding stadia, the proepimeron and the mesepisternum increase in size more, relatively, than do the proepisternum and the mesepimeron, so that in the fifth instar there are marked differences (cf. figs. 82, 86 and 99). In all of the nymphs, the metepimeron is a small posterior lobe, set off by a suture from the metepisternum. The latter lengthens the most rapidly of any part of the thorax and by the fifth instar extends toward the middorsal line. The supracoxal lobes develop gradually and even in the fifth instar nymphs are relatively small. The legs of all nymphs articulate with two processes, one near the plural suture and one on the sternum (fig. 100).

The thoracic spiracles lie in the membrane between the prothorax and mesothorax and in that between the mesothorax and metathorax in the first, second and third instars (figs. 82, 85, 86). In the fourth and fifth the second spiracle becomes associated with the posterior part of the mesepimeron and the first, with that of the proepimeron (figs. 90 and 99).

The abdomen of the first and second instar nymphs is marked by intersegmental lines which are especially noticeable if the abdomen is contracted. The spiracles of the first segment are more dorsal than those of the second through the eighth segments (figs. 82 and 85). The tenth segment is separated from the ninth by a ventral groove (figs. 81 and 83). The dorsal surfaces of the seventh, eighth and the terminal segments bear more heavily sclerotized setose plates. In the third and succeeding instars, the dorsal intersegmental boundaries are marked by dark lines (fig. 88). Well-developed intersegmental muscles run between these dark lines on the dorsal body wall and between the ventral intersegmental lines, indicating that these lines mark the primary segmentation of the abdomen.

Differentiation of the external genitalia begins to become apparent in the fourth instar. In the female, a small dorsal projection of the eighth tergum extends over the reduced ninth segment and the protiger (figs. 95 and 96). A pair of lobular sclerites represent the sternum of the ninth segment (fig. 96). In the female fifth instar nymph the dorsal projection of the eighth tergum is larger (figs. 101, 103); ventrally the sclerotized plates which are the anlage of the first valvifers of the adult female, are joined by a membrane. The ventral sclerites of the ninth segment are partially covered by the eighth segment (fig. 102).

In the male fourth instar nymphs, the eighth abdominal tergum also has a dorsal projection (figs. 92 and 93). Caudad to this the terminal segments are differentiated, forming a dorsal sclerotization which will become the proctiger and a ventral sclerotization, the anlage of the genital capsule (fig. 93). In the fifth instar nymph, tergal projection at the eighth segment is relatively longer but not as long as the proctiger. The genital capsule is larger (fig. 105) and the ninth tergum appears as a dorsolateral lobe (figs. 104, 106).

Discussion of the Nymph

Although several papers consider the nymphal instars of *Hydrometra stagnorum*, comparatively little work has been done on the postembryonic development of *H. martini.* The nymphs of only two other species are mentioned in the literature, those of *H. vittata* (= *H. albolineata*) by Takahashi (1921) and those of *H. gracilenta* by Jordan (1931).

The first description of the complete life history of a hydrometrid was that of Hungerford (1920). Working in Kansas, he found that the nymphal stadia lasted on the average two days, with some taking three to four days. Jordan (1931) found that the nymphal stadia of *H. stagnorum* lasted from four to six days. The average length of the instars of 11 *H. martini* nymphs reared in Michigan in the summer is 3.2 days, with variations of two to five days. In these animals, the first and last stadia were, on the average, longer than the others. The rapid postembryonic development of *H. martini* reported by Hungerford probably is correlated with the warm Kansas temperatures. There is great variation, however, not only in the length of time of development (from egg to adult) of the various individuals, but also in the period that each nymph spends in the different instars.

In an earlier paper Bollweg (1915) described only four nymphal instars in *Hydrometra stagnorum,* but Tevrovsky (1920) and Lundblad (1921a, 1921b) as well as Jordan (1931) found five nymphal instars.

By far the most detailed description and drawings of the hydrometrid nymph are those of Lundblad (1921a, 1921b), who was particularly interested in the proportional growth. He found that the lengthening of the head, which had also been mentioned by Arrow (1895), was especially the result of growth of the "präokularen parallelseitigen Partie." In *H. martini,* also, this region grows most rapidly (see Table 4, fig. 4). Jordan (1931) found, however, that the preocular region is less elongate in nymphs of *H. gracilenta* than in those of *H. stagnorum.*

The observations made by Lundblad (1921b) on the development of the wing pads in the apterous form were also confirmed in the present work. In both species, these are apparent first in the second and third instar nymphs as slightly produced corners of the terga. In the fourth instar these tergal angles are differentiated as wing pads and in the fifth continue to elongate. Lundblad did not include descriptions of the nymphs of the winged form, nor has any subsequent paper.

Lundblad was concerned also with the segmentation of the abdomen. He identified nine segments including the first which Bollweg (1915) seems not to have found in the late instars because of the overgrowth of the metathorax and small size of the first segment. Lundblad mentioned the sclerotization of the dorsal plates of the terminal abdominal segments but he did not consider the differentiation of the external genitalia.

One of the most interesting features in the development of the hydrometrid nymph is the extreme variation in the total body length. This was recognized by Hungerford (1920) who used the length of the animal from the tip of the head rather than the length of the body as a criterion for the recognition of the various instars. The lengths of the appendages, which were tabulated by Lundblad for *H. stagnorum* and by Hungerford for *H. martini*, are constant throughout each stadium. Both Jordan and Lundblad, found that the body length varied during each nymphal stadium. Bollweg (1915) included measurements for four instars; he omitted the second.

None of these investigators correlated the differences in size in a given stadium with the expansion of the abdomen which results from distention of the gut with air or food and water. Both Tevrovsky (1920) and Lundblad (1921a) figured first instar nymphs with extremely contracted abdomens. In *Hydrometra martini*, the abdomen is of minimum size approximately a half hour after eclosion and later in the stadium if the nymph does not eat or becomes dry. The larger size of adult females was mentioned by Jordan (1931) but he did not correlate variation of size of the nymphs with sex.

Allometric growth, that is, "growth of a part at a different rate from that of the body as a whole or of a standard" (Huxley and Tessier, 1936, p. 380), is a pattern frequently found in insects. Clark and Hersch published a very comprehensive study of relative growth of *Notonecta undulata* in 1940. By measuring anesthetized animals, they were able to determine growth gradients in individual insects as well as to calculate averages for males and females. On the average, each of the legs increased in length at about the rate of total body length in *Notonecta*. In *Hydrometra* leg length averaged 87% of body length. Body width increased an average of 76% in the *Notonecta* males in contrast to the 40% increase found in *Hydrometra*.

The similarities in behavior, locomotion and feeding habits of the nymphs to those of the adults which are reported in the present study in general confirm the observations of other investigators. Arrow (1895) stated that nymphs reared in the laboratory fed only on springtails until the last instar when they took aphids. Hungerford (1920) observed that the nymphs as well as the adults eat entomostracans and a variety of insects, including weaker hydrometrids. Both Jordan (1931) and Schumann (1934) also mentioned cannibalism.

Investigators working with both *Hydrometra stagnorum* (Arrow, 1895; Jordan, 1931; Schumann, 1934) and *H. martini* (Martin, 1900) have found that the nymphs stay closer to land and are more susceptible to drowning than are the adults. On the other hand, Takahashi (1921) described the nymphs of *H. vittata* (= *H. albolineata*) as swimming under the water and crawling from it to the surface film. Certainly, under laboratory conditions, *H. martini* nymphs are capable of this type of locomotion.

Two curious habits of the nymphs, the elevation-depression movements which were observed also in the adults and the carrying of the abdomen curved over the back, have been noted by Schumann (1934) and Jordan (1931).

DIMORPHISM

Observations

Dimorphism in *Hydrometra martini* is evidenced by two patterns of wing development; an apterous form which has vestigial wing pads projecting just beyond the pronotum and a macropterous form in which the two pairs of wings extend beyond the middle of the sixth abdominal segment. In the field, the adults of these categories are differentiated easily and the wing pattern of the fourth and fifth instar nymphs can be identified with good light. Third instar nymphs have been separated only with the aid of a binocular microscope.

Hydrometrids with long wings are scarce and those without wings are abundant in both Massachusetts and Michigan. In the four summers in Michigan, an average of about six adults or nymphs of the macropterous form were taken whereas hundreds of apterous animals were seen. The ratio was perhaps one winged to 100 or more wingless hydrometrids. In Massachusetts a higher percentage of winged forms was collected; it was estimated that one in 45 was macropterous. In the autumn of 1950, collections at the Lithia pond yielded a ratio of about one winged individual to ten of the wingless type. At that time, the pond had little water and the animals including the hydrometrids, were concentrated. Twenty-seven winged forms were taken.

Apterous and macropterous males and females have been collected through the year. At least four mating pairs of which one individual was winged and the other wingless have been collected in the field. In the laboratory they mate readily and produce fertile eggs.

Studies in the laboratory have been directed toward gaining an understanding of the cause of development of long wings in some individuals and of only vestiges in others. In the summer of 1949, a series of nymphs, 26 of which lived to or beyond the fourth instar, were reared from eggs of apterous females crossed with apterous males, under constant light with a temperature of about 30°. All of the 26 individuals which lived to or beyond the fourth instar were apterous. In the summer of 1950, a group of similar nymphs were reared at 30° in a constant temperature oven. The glass door of this incubator allowed normal daylight to enter. The 31 animals of this series were also wingless. Of the hundreds of nymphs reared from eggs of apterous individuals under normal laboratory conditions during all reasons of the year, none were macropterous.

Offspring of other crosses (winged ♀ x winged ♂, wingless ♀ x winged ♂, winged ♀ x wingless ♂) have been reared in the laboratory. Since female hydrometrids store sperm for long periods of time, only those which emerged from isolated fifth-instar nymphs or teneral individuals were used. Winged females produced fewer eggs and were shorter lived in the laboratory than wingless individuals. Because of the small numbers of animals, the results of my studies are not conclusive but they suggest that some form of inheritance governs wing form. These results are as follows: winged ♀ x wingless ♂ gave 16 wingless offspring; wingless ♀ x winged ♂ gave 9 wingless offspring; winged ♀ x winged ♂ gave 21 offspring of which 19 were wingless and 2 winged.

Some information on the distribution of winged and wingless forms of *Hydrometra martini* has been assembled from the series in the Snow Entomological Museum at the University of Kansas. The collection includes 140 specimens taken from three localities in Kansas in the autumns of 1924, 1925 and 1926, of which 3 or about 2 per cent are macropterous. A series of 104 hydrometrids taken from Sedge Point Pool, Douglas Lake, Michigan in June and July of 1923 is made up of 101 apterous and 3 or approximately 3 per cent of macropterous individuals.

Discussion

The presence or absence of wings, as well as variations in their length, has been of interest to investigators of many groups of Pterogota. In relatively few species are the causes of these variations well understood. Poisson (1946) summarized the problem of apterism in the Hemiptera. Ford (1940) reviewed polymorphism and taxonomy of insects.

In an earlier review article, Larsén (1930) discussed the loss of flight by reduction of wing musculature and also variation in types of wings found in the aquatic and semiaquatic Hemiptera. Of the insects in these groups, the mechanism of wing development is best understood in *Aphelocheirus aestivalis,* a truly aquatic bug. Larsén (1931) found in the laboratory that individuals reared in aquaria with running water were winged whereas wing development was suppressed in animals kept during their last nymphal instar in aquaria equipped with air pumps.

As many as six distinct wing types are known in some European species of *Gerris* (Ekblom, 1927; Jordan, 1947). All of these may occur in one locality. Some species, however, are known only from macropterous and others only from apterous or micropterous specimens. Observations in Finland of distribution of polymorphism in *Gerris najas* and *G. lacustris* led Sahlberg (1868) to believe that brachypterous forms were significantly more abundant in the north, and macropterous forms in the south. This was substantiated by Lindberg (1929) who found that brachypterous *Gerris lacustris* was the common form in the coastal areas of the outer archipelago as well as in northern Lapland. Lindberg also correlated the collection of a larger ratio of winged to wingless forms of *G. najas* in Finland with the warm temperature in 1917-1925. Jordan (1943) has found that *Gerris odontogaster* is also found most often in the brachypterous form in the north and the macropterous form in the south of Finland. Ekblom (1950) collected only long winged *G. odontogaster* at Skellefteå in Sweden.

Another worker, von Mitis (1937), correlated temperature with wing form. Working with *Gerris* in Germany, he found that the spring generation was brachypterous but the generation which developed during the warm summer weather was macropterous. Similarly, Ekblom (1927) collected fewer winged animals at Piteå than at colder Stockholm. Larsén (1950) observed *G. lacustris* in southern Sweden and found more rapid postembryonic development in individuals with reduced wings than in those with long wings.

The only studies reported in the literature of crossing the winged and wingless forms of gerrids are those of Ekblom (1927 and 1950) and those of Poisson (1924). Poisson found that in some crosses of *G. lacustris* macropterous x macropterous gave about 91 per cent macropterous and 9 per cent brachypterous; in others this cross yielded only macropterous individuals. In the same species, brachypterous x brachypterous gave above 80 per cent brachypterous and 20 per cent macropterous. Poisson also varied environmental conditions in some of the rearings but he found that the variations of food and temperature which he used did not influence the expression of wings. In 1927, Ekblom working with *Gerris asper* crossed apterous x apterous and micropterous x macropterous forms. Both yielded only macropterous offspring. Four macropterous females which had resulted from the micropterous x macropterous cross were mated with an apterous male. Most of the offspring of these crosses were macropterous but a few were micropterous and a few, apterous.

Ekblom reported in 1950 on crosses made in the laboratory with *Gerris odontogaster,* all of the adults at Skellefteå, Sweden were macropterous. Of the 91 offspring reared in the laboratory 90 were macropterous and one brachypterous.

Poisson (1924) has also described sexual dimorphism which is correlated with wing dimorphism in *Gerris odontogaster.* Micropterous males of this species have lateral teeth on the 6th abdominal segment, which never occur in macropterous individuals.

Comparatively little work has been done on variations of wing form in *Hydrometra.* In contrast to the dimorphic *Hydrometra martini,* both of the European species, *H. stagnorum* and *H. gracilenta,* are polymorphic. Poisson (1924) and Walton (1938) have found that the apterous form of *Hydrometra stagnorum* is the most common in France and England, respectively, but that macropterous and brachypterous forms are also found. Polymorphic forms like those of *H. stagnorum* have been described in *H. gracilenta* by Walton (1943) from animals taken in England. Both there and in Germany *H. gracilenta* is less frequently collected than is *H. stagnorum.* That the brachypterous and macropterous forms are rare in Germany is obvious from the report of Schumann (1934) who collected only one winged *H. stagnorum* and from that of Jordan (1931) who collected only two winged forms, one of each species.

Poisson (1924) reported that the offspring of wingless individuals were always wingless in his rearings and that only winged offspring resulted from two pairs of macropterous individuals, which he crossed in the laboratory. Although he attempted to cross winged ♀ x wingless ♂ and wingless ♀ x winged ♂, these animals did not mate. This condition, which he termed "amixie," he believed important in the origin of new species.

However, Jordan (1931) reported collecting mating pairs in the field in which one individual was winged and the other wingless. Such a pair of *H. gracilenta* continued to mate after they were bought into the laboratory. Jordan, realizing that the female might have sperm stored from a previous mating, destroyed the eggs laid during the first ten days. Those deposited after that time were fertile.

No study of the length of time which females may retain viable sperm has been reported for *Hydrometra stagnorum.* If, like *H. martini,* this species can retain sperm for a period of months, the eggs observed by Jordan possibly were fertilized by a previous impregnation.

The occurrence of winged and wingless individuals in a relatively constant ratio indicates that this is a balanced population. Balanced populations are defined by Ford (1940, p. 493) as being those in which "two or more forms of the same species are maintained in optimum proportions, a departure from which, in either direction, constitutes a disadvantage." In *Hydrometra,* the most apparent advantage of the winged condition is motility; these individuals can escape an unfavorable environment by flying to different areas. Laboratory studies indicate lower reproductive and survival rates which, if they occur in nature, would be disadvantageous. The possibility exists that the winged condition is inherited with a lethal factor in some parts of its range. The inheritance of a recessive lethal factor with a factor for color occurs in dimorphic females of some species of the pierid genus *Colias* (Ford, 1937). The lower reproductive capacity of winged hydrometrids might result from the greater demands for nourishment by the thoracic muscles and the subsequent deficiency for optimum ovarian growth.

SUMMARY AND CONCLUSIONS

Hydrometra martini is the only species of the family Hydrometridae in the northern part of the United States. Water measurer and marsh treader are vernacular names applied to insects of this family and indicate their characteristically deliberate gait. Adults of *H. martini* are slender; they measure approximately 10 mm. in length and 0.5 mm. in width. The exoskeleton is heavy and, because of the fusion of the sternal area, rigid. Most individuals are apterous, the wings being represented by small straplike processes; a few have well-developed wings which extend to the sixth abdominal segment. The nymphs, especially those of the early instars, are proportionately less elongate and their exoskeletons are lightly sclerotized.

These insects are found throughout the spring and summer on still or slowly moving waters and on the banks. They walk on the surface film and crawl over the floating and emergent vegetation, preying upon recently dead or living insects. Reproductive activity is continuous from early spring until late summer. There are three generations and a partial fourth generation per year in both Michigan and Massachusetts. In the fall, when the water temperature approaches 15°C., the adults of the overwintering generation crawl on land and seek shelter in depressions of the earth or under decaying plants. Here they remain until spring when the migration to water takes place. Since females collected in the winter and early spring lay fertile eggs in the laboratory, viable sperm must be stored from copulation in the fall.

The elaborate sculpturing of the egg of *Hydrometra martini* results from the subdivision of the exochorion into minute air chambers. The length of time of development of the embryo depends upon the temperature; at 25° this period is 11 to 14 days. The hatching process, which is rapid and uniform in nature includes the molting of an embryonic cuticle.

From the time the nymph walks away from the egg shell, its activities closely resemble those of the adult. This is especially true of its locomotion, its grooming and its feeding.

The morphological changes are more marked and involve both proportional growth and differentiation. With each molt, the head increases in length to a much greater extent than in width. This growth is especially marked in the preocular region. The head capsules of the nymphs are lightly sclerotized, but in them, as in the adults, there are differentiated sclerites associated with the mouth parts.

The mouth parts, like those of all hemipterans, consist of a labium which forms a sheath enclosing the mandibular and maxillary stylets. The labrum partly covers the base of this sheath and the elongate epipharynx extends into it. The maxillae form a single channel through which saliva passes to the prey and food materials are pumped back to the pharynx. The complex musculature of the mouth parts is contained entirely within the elongate head capsule.

The well-developed salivary glands lie in the anterior part of the thorax.

Changes in the developing thorax involve the fusion of sclerites and the differentiation of the tergum associated with wing formation. The fusion in the thorax includes the union of the pleura with the sterna which occurs only in the adult and also the reduction of the membranes joining the regions of the thorax in the nymphs to the sutures found in the adults. The development of the supracoxal lobes of the episterna and epimera begins in the fourth instar nymphs. The articulation of the legs of both the nymphs and adults is such that movement of the coxae is on a horizontal plane. The legs are slender and especially in the adults, elongate. The setae of the tarsi and the distal parts of the tibiae are used in the almost continuous grooming motions which help in keeping these surfaces hydrofuge.

Differentiation of the tergum is especially associated with wing formation. The pronotum, which completely covers the mesotergum in the adults, is not markedly developed even in the fifth instar nymphs. The mesoterga and metaterga of the first instar nymphs are rectangular plates; the posterior angles of these sclerites indicate the development of wing pads in the second and succeeding instars. In the third instar, the wing pads of individuals which will become macropterous are somewhat larger and in the fourth and fifth instar nymphs these are conspicuously larger than the wing pads of potentially apterous individuals. The mesonota of macropterous nymphs are not differentiated into sclerites as are those of adults. The metanotum is progressively compressed by the upward growth of the metaepisterna. In the fifth instar nymphs, the metanotum is a rather wide membrane but in the adult, it is represented by an external line and an internal fold on which the metanotal leg muscles take their origin.

The mechanisms regulating wing growth in *Hydrometra* are not known. About three per cent of the specimens of *H. martini* which were collected in Michigan and Kansas are macropterous. Genetic control is suggested by crosses made in the laboratory. The offspring of two apterous individuals are always apterous. In the small numbers of crosses involving macropterous individuals, only a few of the offspring of two macropterous parents and none of those having one apterous and one macropterous parent, were macropterous.

The first pair of thoracic spiracles lies in the posterior border of the proepimera and the second, in that of the mesoepimera in the nymphs. Each pair shifts anteriorly to lie just behind the supracoxal lobe of the adult epimera. In the nymph each of the abdominal segments I through VIII bears a pair of spiracles. Those of segments I and VIII are lost in the adult. The tracheal system consists of two independent dorsolateral trunks which extend into the head, tracheae to the viscera, and tracheae to the ventral body-wall.

The nymphal abdomen consists of ten segments. In the first three instars, each of these, except the reduced tenth segment, is a simple cylinder separated from adjacent segments by secondary segmentation. In the third and succeeding instars the dorsolateral parts of the intersegmental boundaries are marked by heavy dark lines, and in the fourth and fifth instar nymphs the terminal segments are modified with the differentiation of the external genitalia.

In the adult, the first abdominal segment is greatly reduced and all of the pregenital segments are fused ventrally and laterally; segmentation is indicated only by the terga and by the positions of the abdominal spiracles.

The external genitalia of the female consist of broad plates which serve as a guide in the deposition of the egg; they show considerable reduction in comparison with the oviposition apparatus of more nearly typical hemipterans. The male external genitalia closely resemble those of related insects; a genital capsule formed from the ninth abdominal segment bears a telescoped aedeagus and a pair of claspers or parameres.

The internal organs follow the pattern of other hemipterans although these organs are attenuated, following the body form. The female reproductive system includes a pair of ovaries each of which consists of seven ovarioles. Under optimum conditions, each ovariole can produce an egg per day. The ducts from the ovaries are simple; the seminal receptacle associated with them may store sperm for a period of months. The male reproductive system consists of a pair of elongated testes, each of which is connected by a vas deferens with a seminal vesicle, and a common ejaculatory duct. The digestive system is a simple tube; the ventriculus is especially long. The salivary glands lie in the thorax and open at the junction of the maxillae by a single duct. Their secretion has a toxic effect on the prey. The compact central nervous system is composed of the fused ganglia of the head, thorax and abdomen and is found in the posterior part of the head and the anterior part of the thorax. The dorsal blood vessel extends from the seventh abdominal segment to the posterior part of the head.

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PLATE I

FIG. 5. Dorsal view of the head.
FIG. 6. Ventral view of the head.
FIG. 7. Lateral view of the head.
FIG. 8. Anteclypeus, labrum and epipharynx in lateral view.
FIG. 9. Anteclypeus, labrum and epipharynx in ventral view.

PLATE I

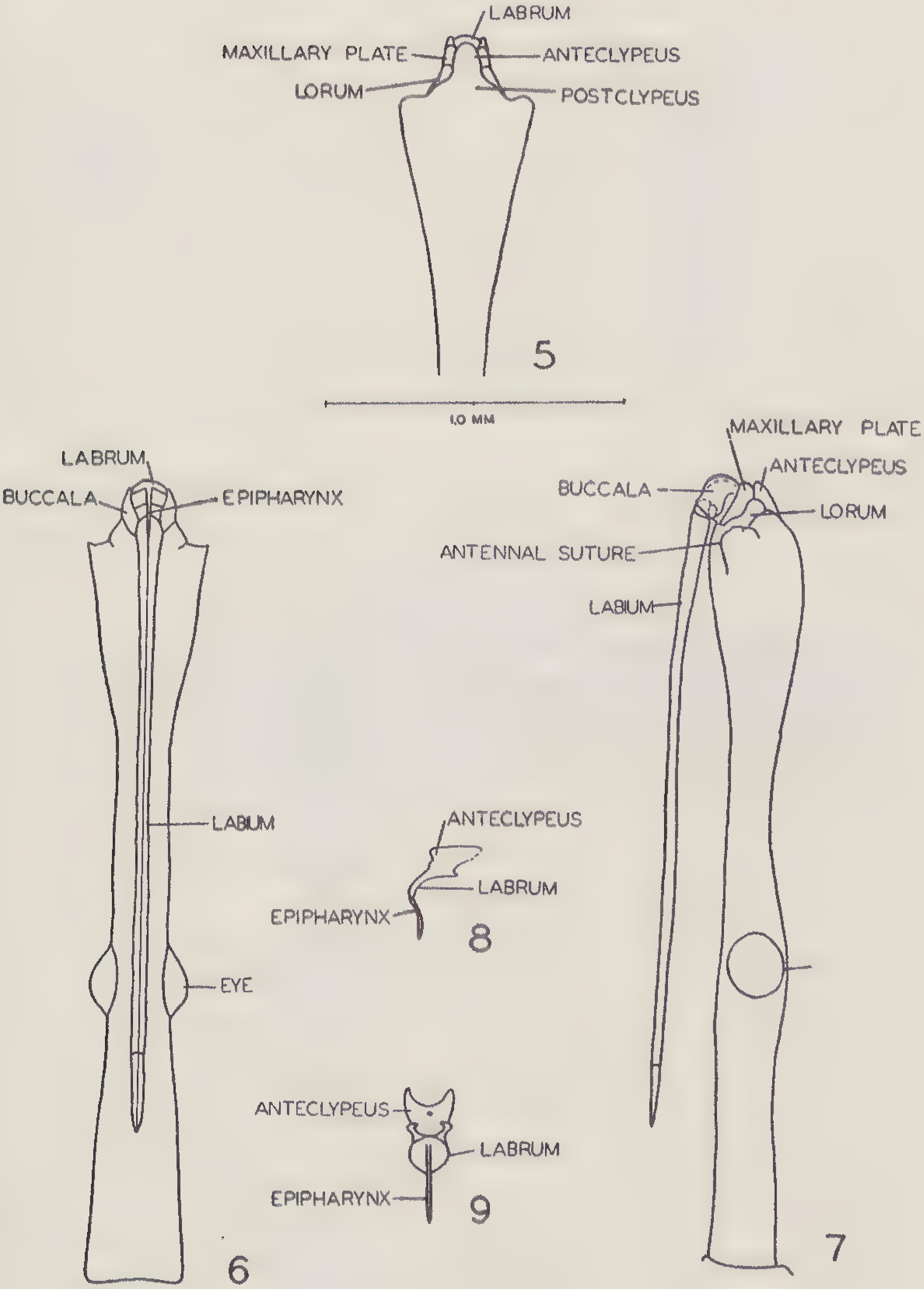

LABRUM
MAXILLARY PLATE
ANTECLYPEUS
LORUM
POSTCLYPEUS
5
1.0 MM
LABRUM
BUCCALA
EPIPHARYNX
LABIUM
EYE
6
MAXILLARY PLATE
ANTECLYPEUS
BUCCALA
LORUM
ANTENNAL SUTURE
LABIUM
7
ANTECLYPEUS
LABRUM
EPIPHARYNX
8
ANTECLYPEUS
LABRUM
EPIPHARYNX
9

PLATE II

FIG. 10. Right antenna in medial view.

FIG. 11. Mandibular apparatus. Right mandible in median view.

FIG. 12. Maxillary apparatus. Dorsal view with protractor and retractor muscles of the right maxilla removed to show the maxillary sheath.

PLATE II

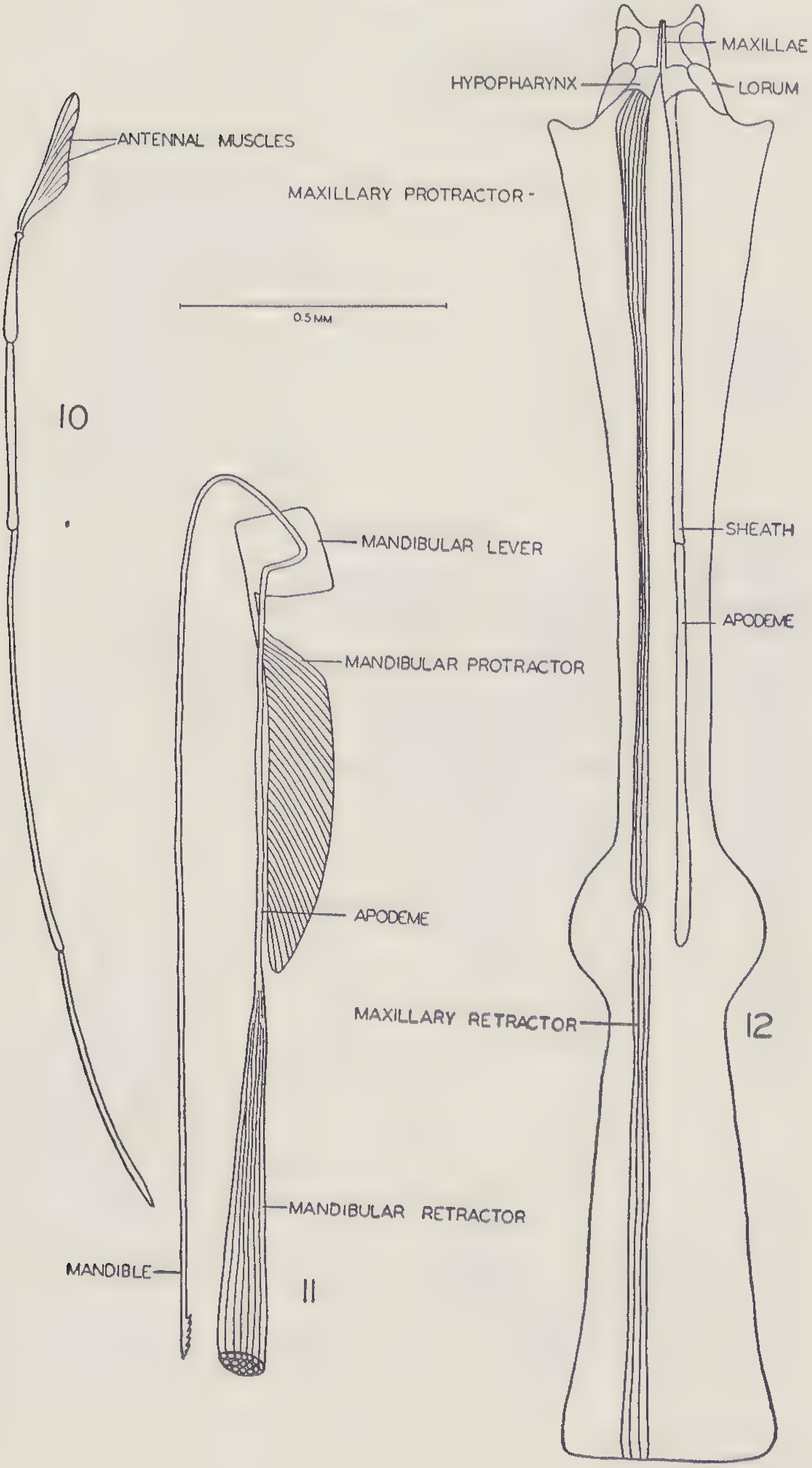

MAXILLAE
HYPOPHARYNX
LORUM
ANTENNAL MUSCLES
MAXILLARY PROTRACTOR
0.5 MM
10
MANDIBULAR LEVER
SHEATH
APODEME
MANDIBULAR PROTRACTOR
APODEME
MAXILLARY RETRACTOR
12
MANDIBULAR RETRACTOR
MANDIBLE
11

PLATE III

FIG. 13. Ganglia of the central nervous system.

FIG. 14. Cross section of the labium through the third segment.

FIG. 15. Salivary syringe.

FIG. 16. Cross section of head at the level of the mandibular lever.

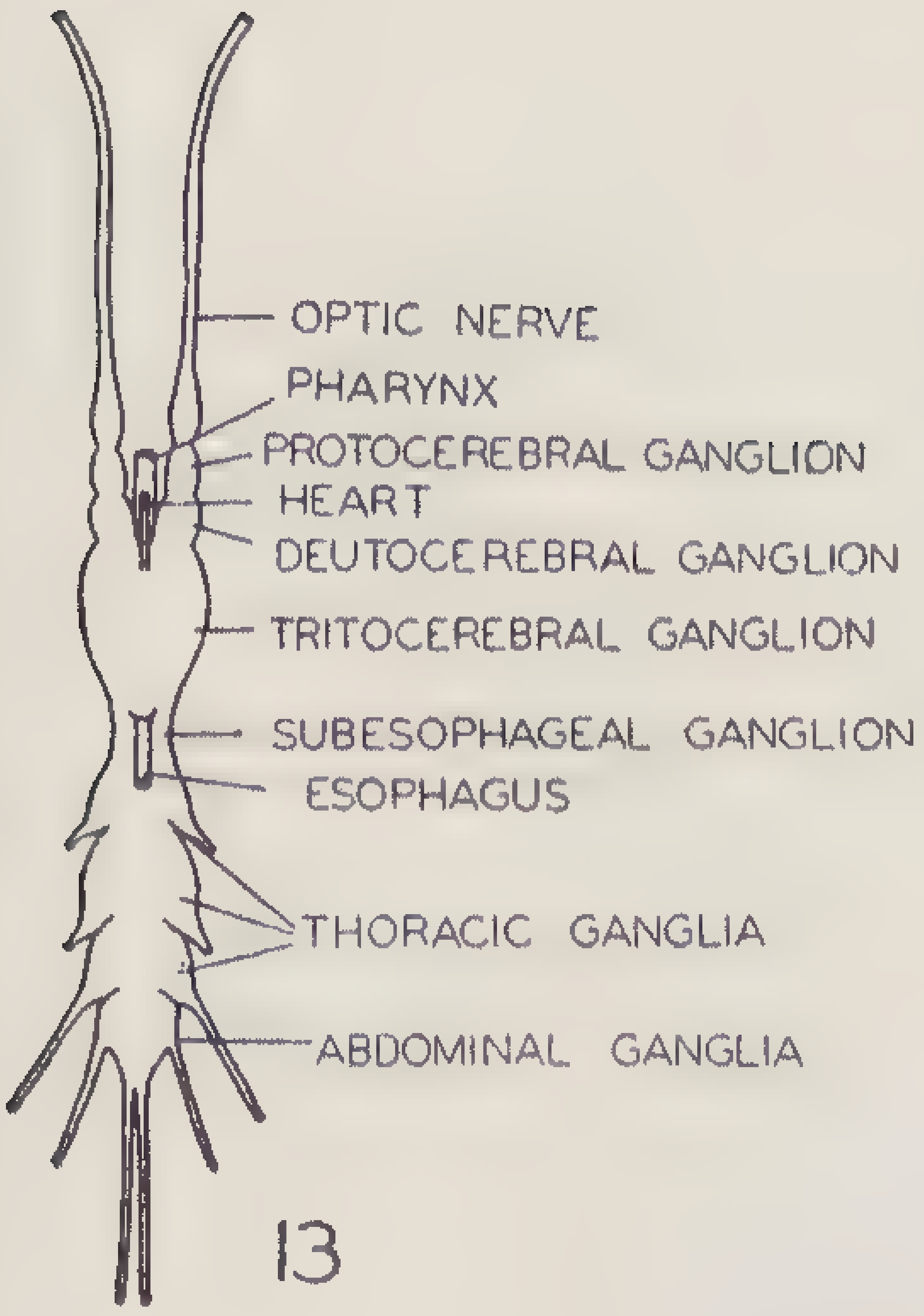
FIG. 17. Tip of right maxilla.

FIG. 18. Tip of left maxilla.

FIG. 19. Anterior part of the head dissected to show the mandibular apparatus and the pharynx.

FIG. 20. Frontal view of the head.

PLATE III



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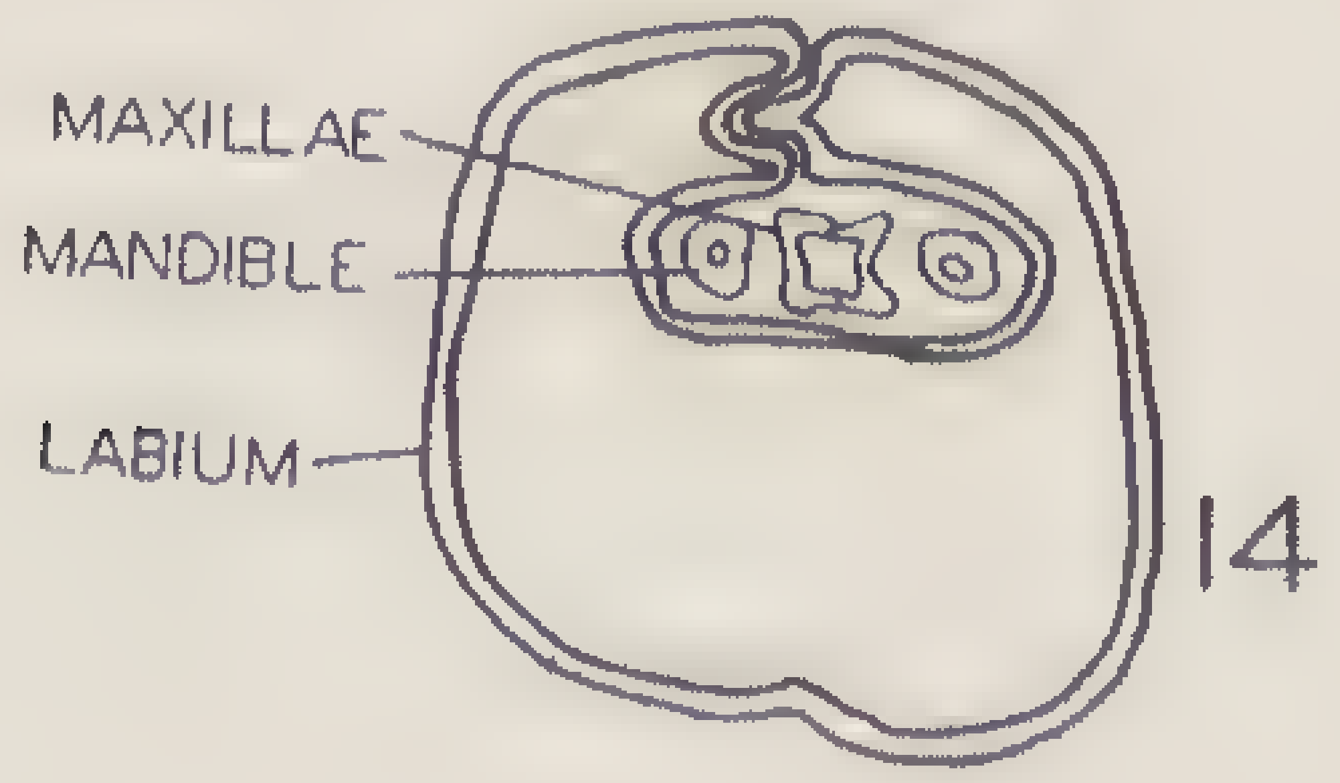

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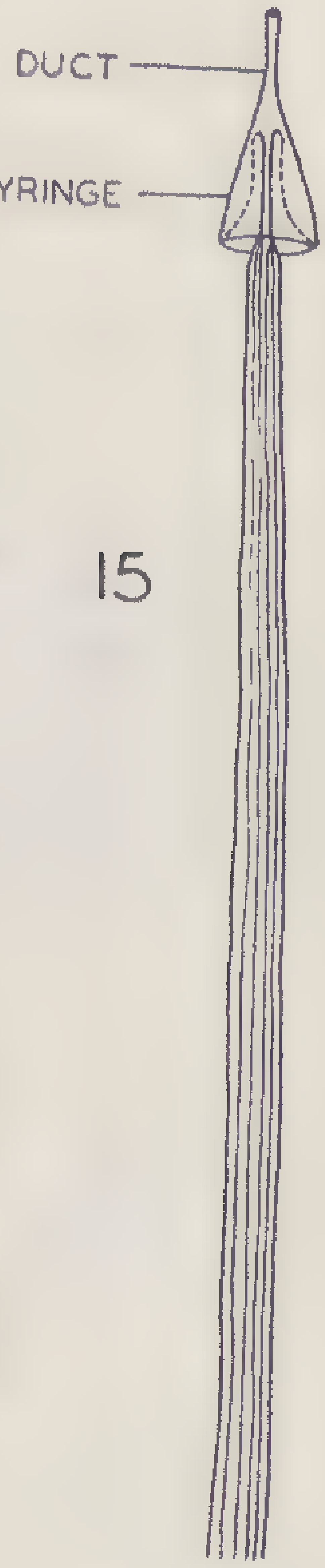

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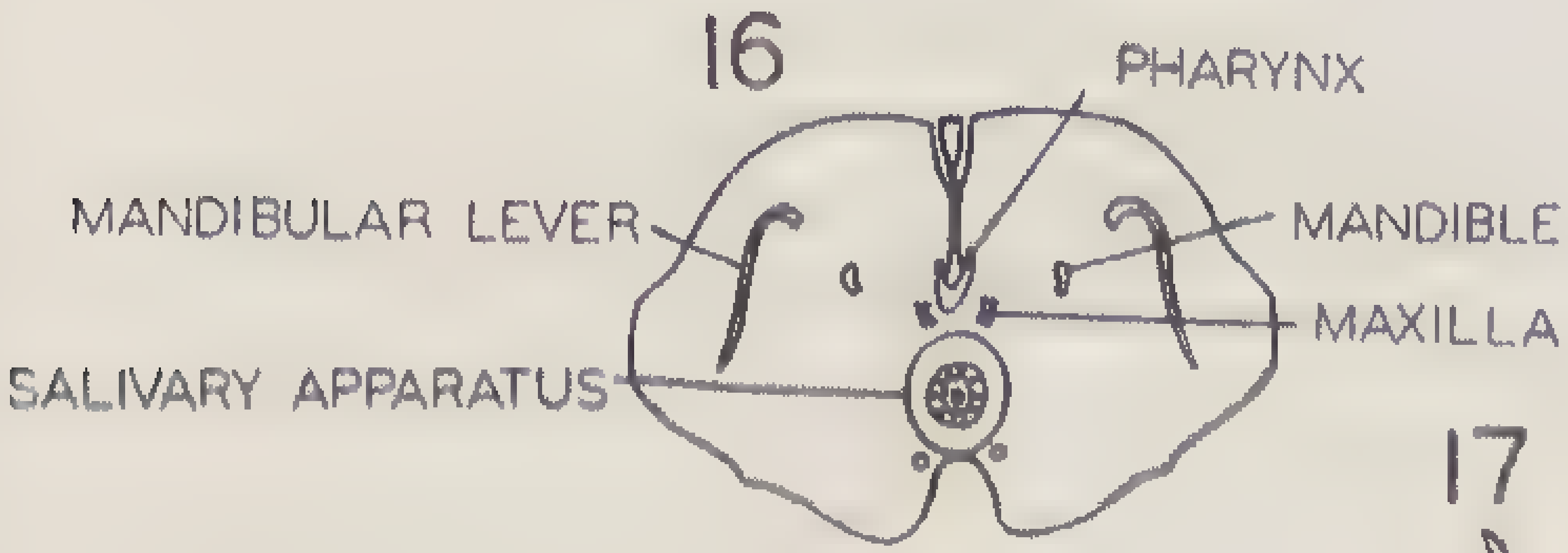

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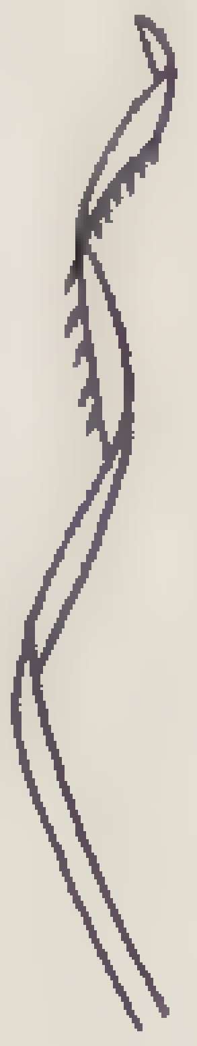

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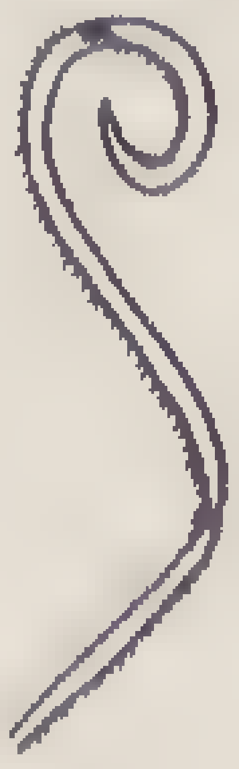

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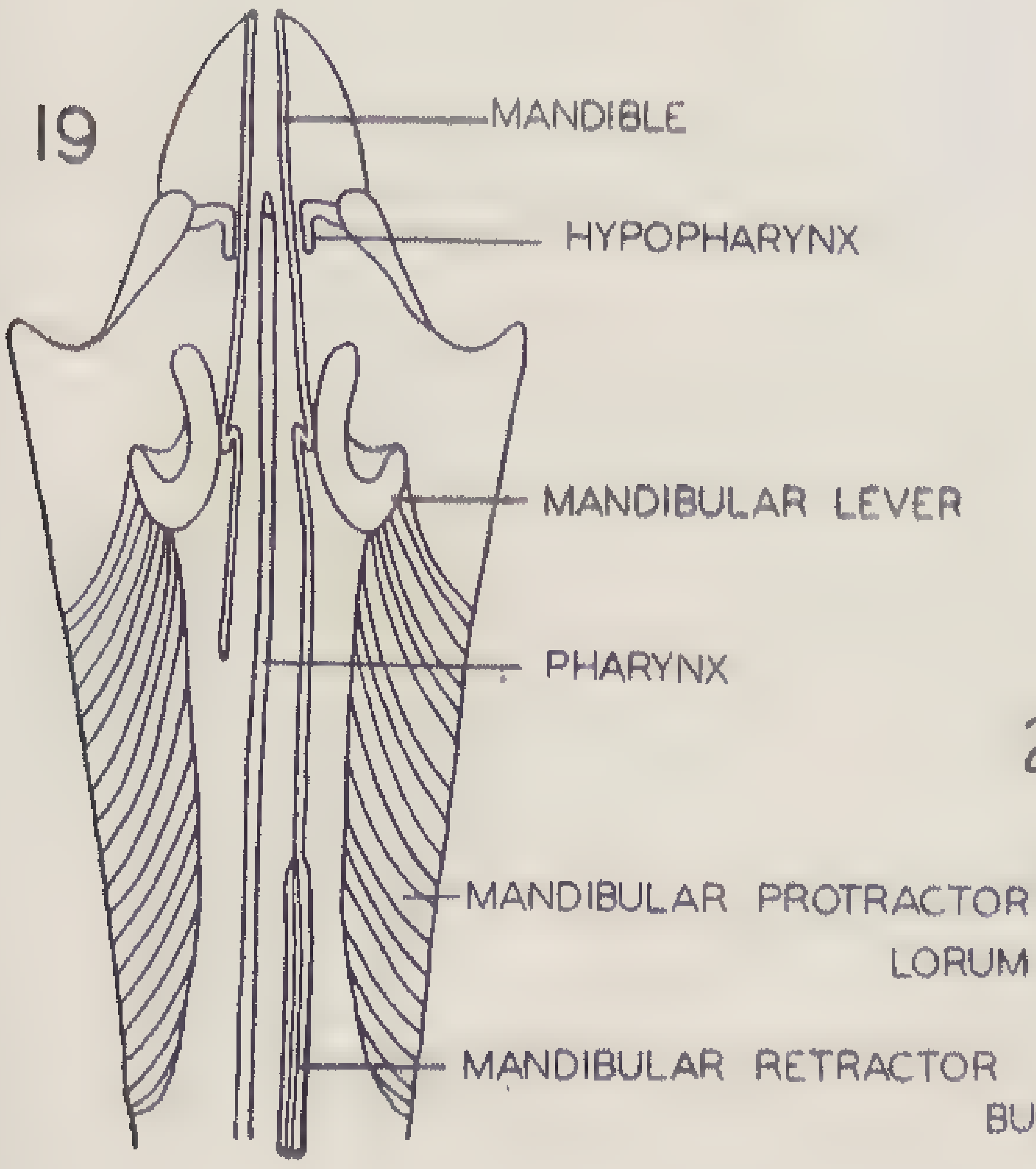

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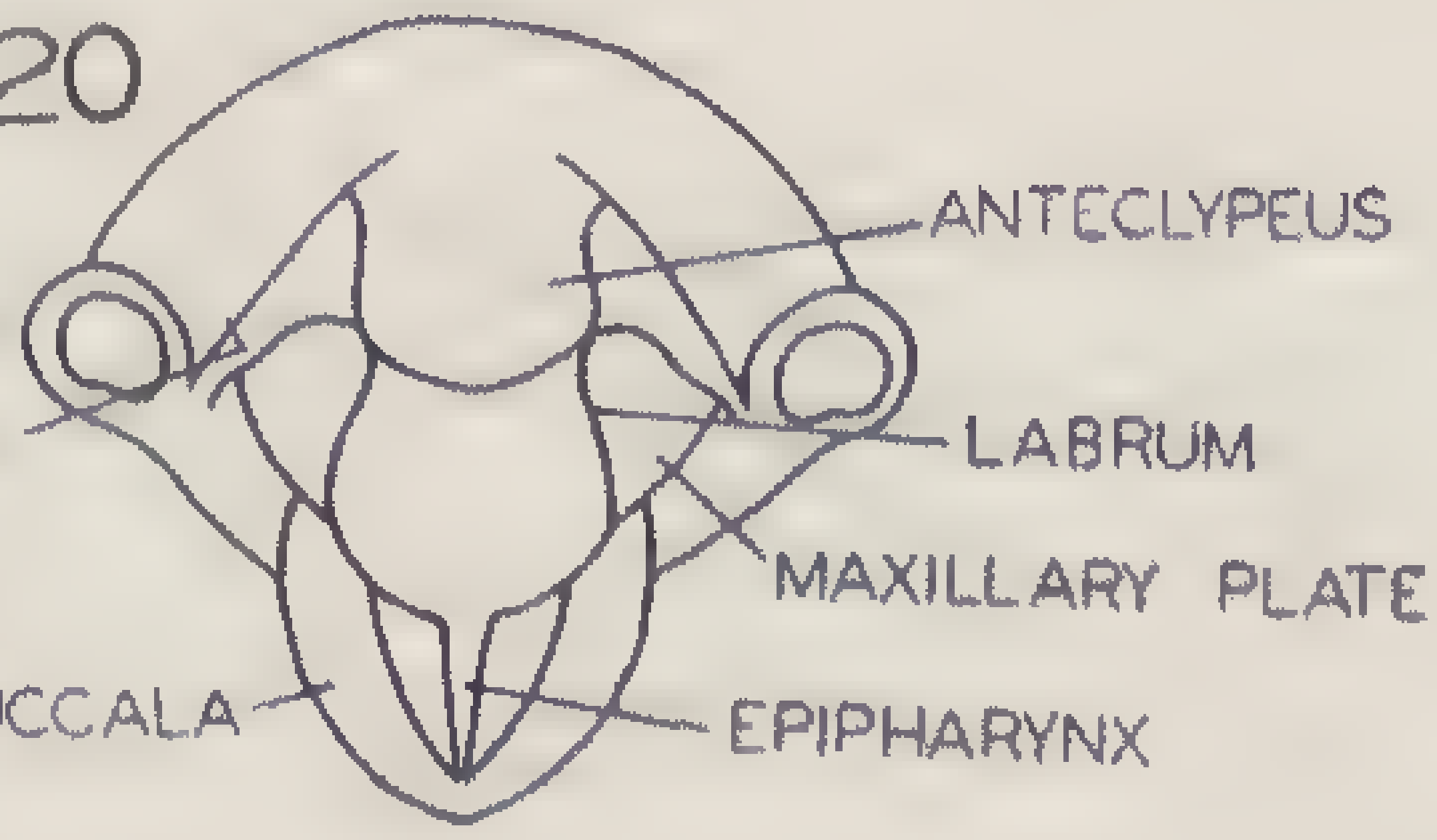
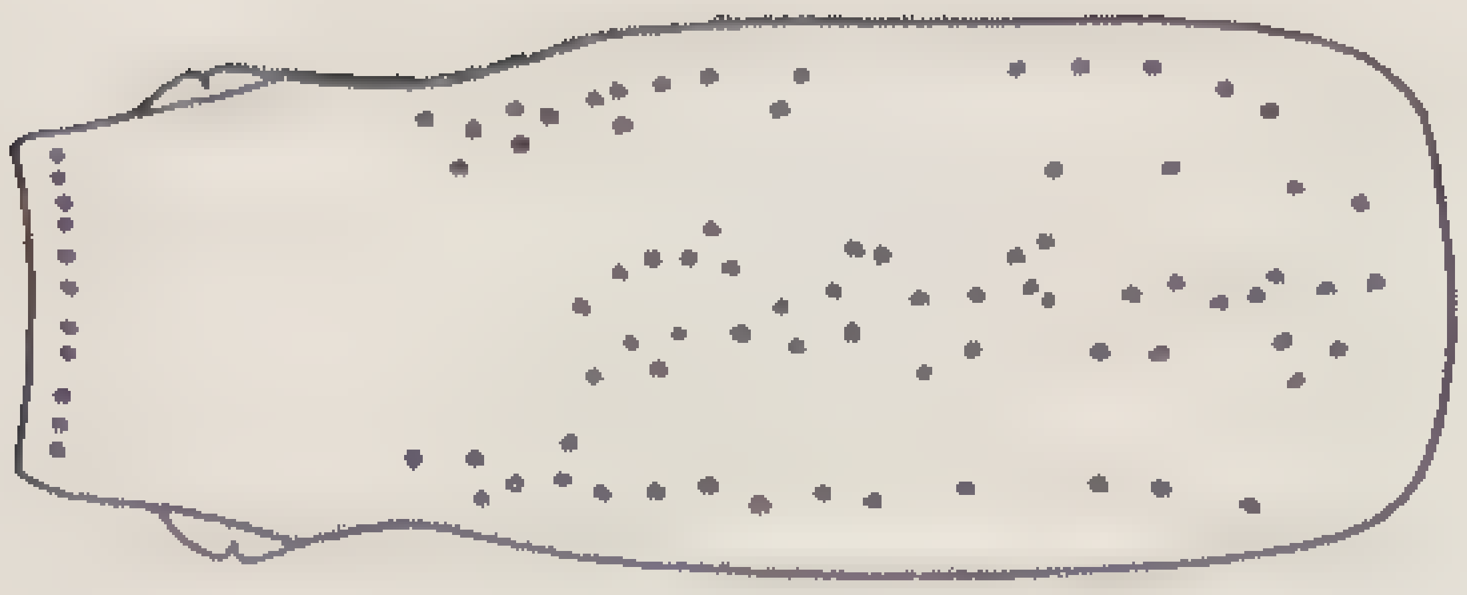


PLATE IV

FIG. 21. Pronotum of winged adult. Dorsal view.
FIG. 22. Pronotum of winged adult. Lateral view.
FIG. 23. Pronotum of wingless adult. Dorsal view.
FIG. 24. Pronotum of wingless adult. Lateral view.
FIG. 25. Pterothorax of wingless adult. Lateral view.
FIG. 26. Pterothorax of wingless adult. Dorsal view.
FIG. 27. Thorax of wingless adult. Ventral view.

PLATE IV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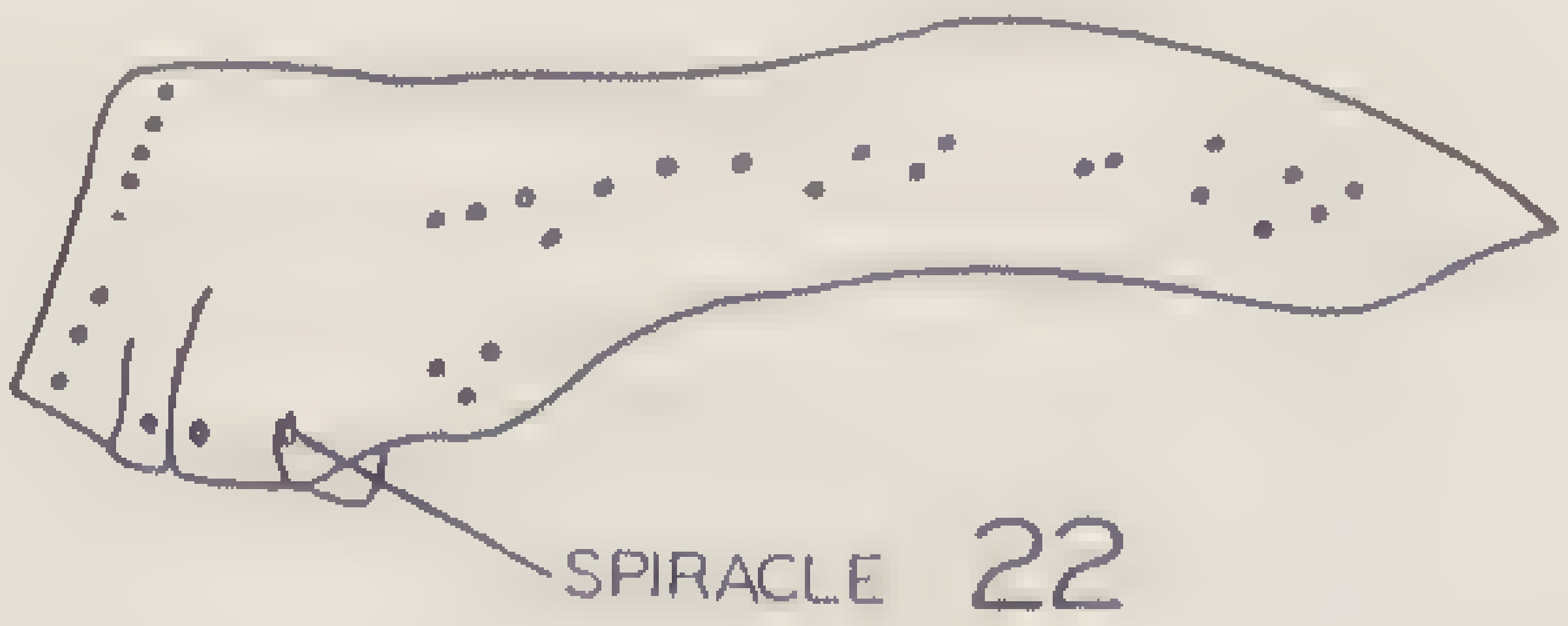

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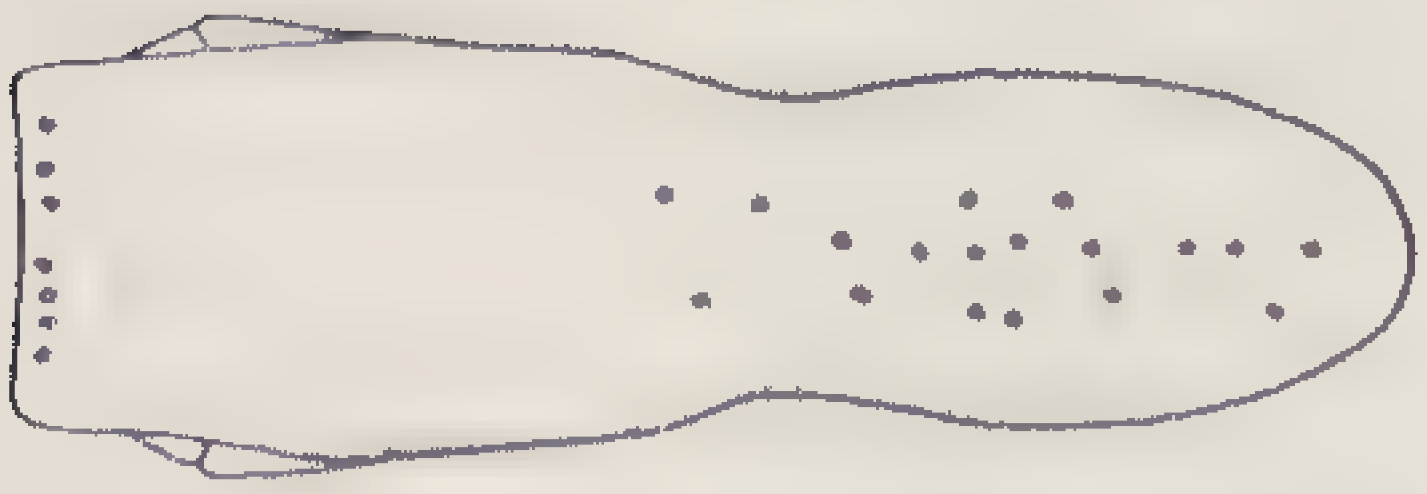
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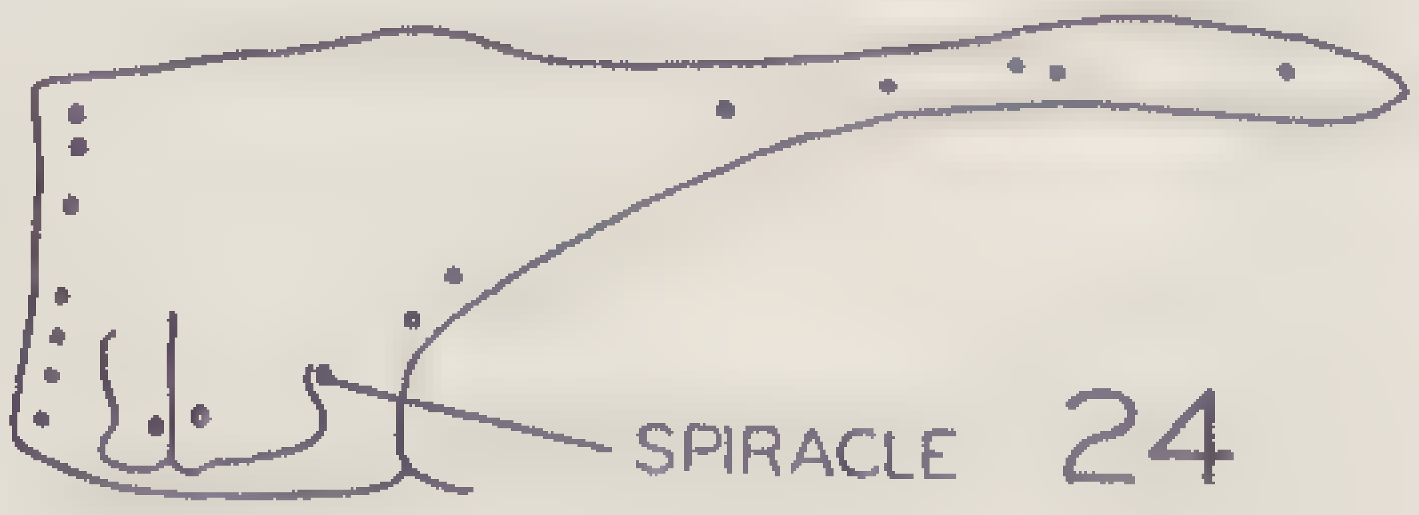

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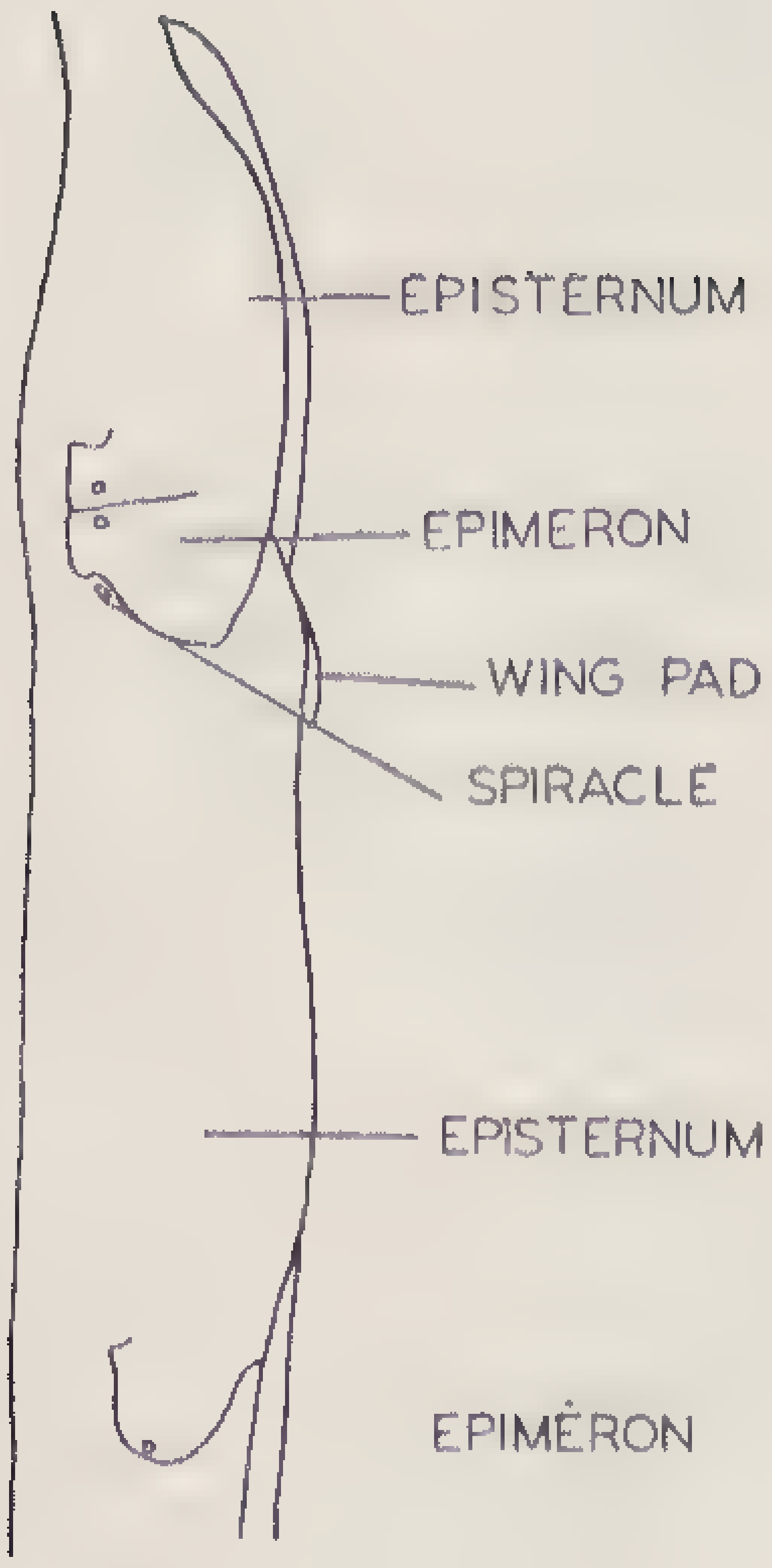

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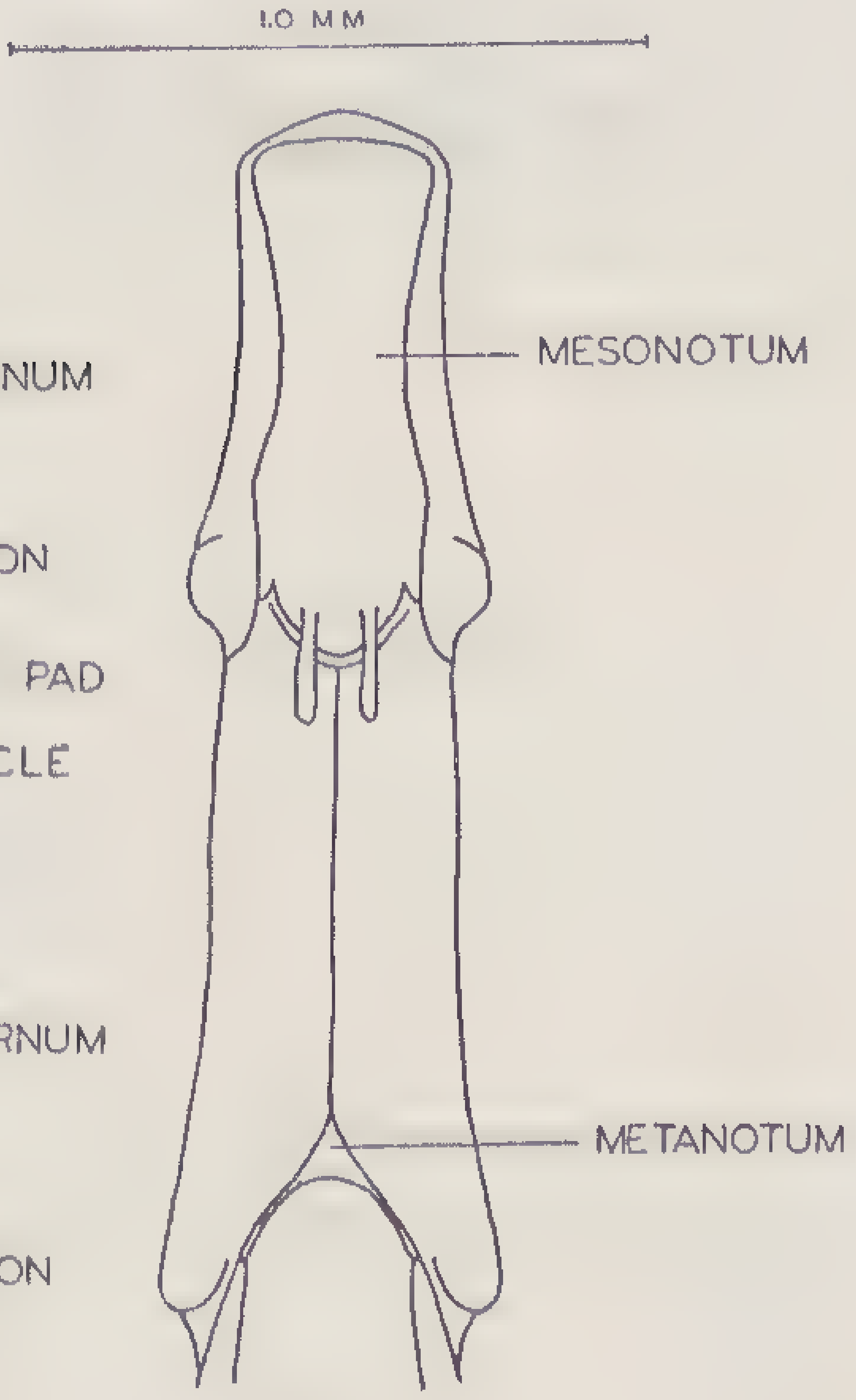

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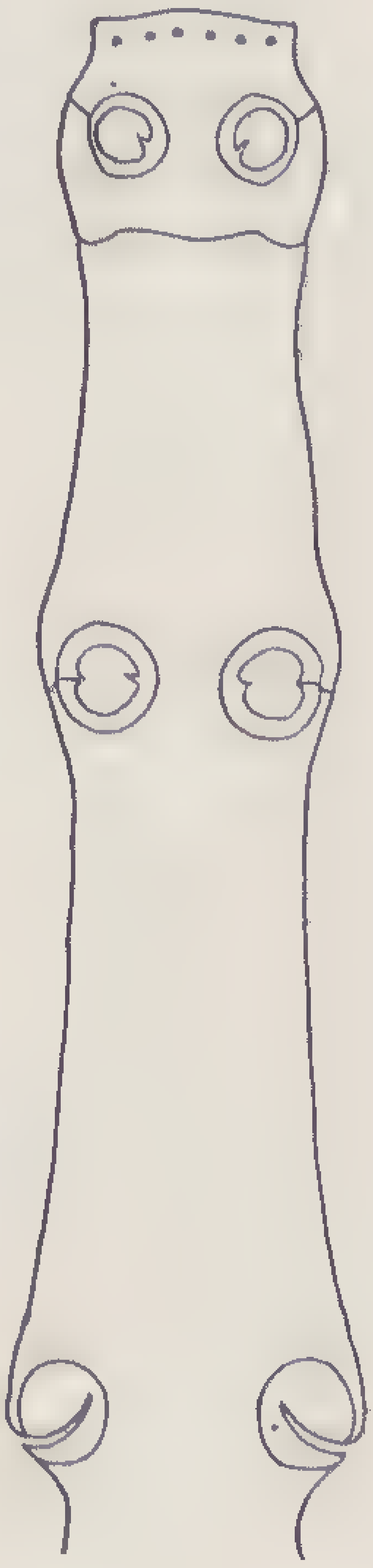
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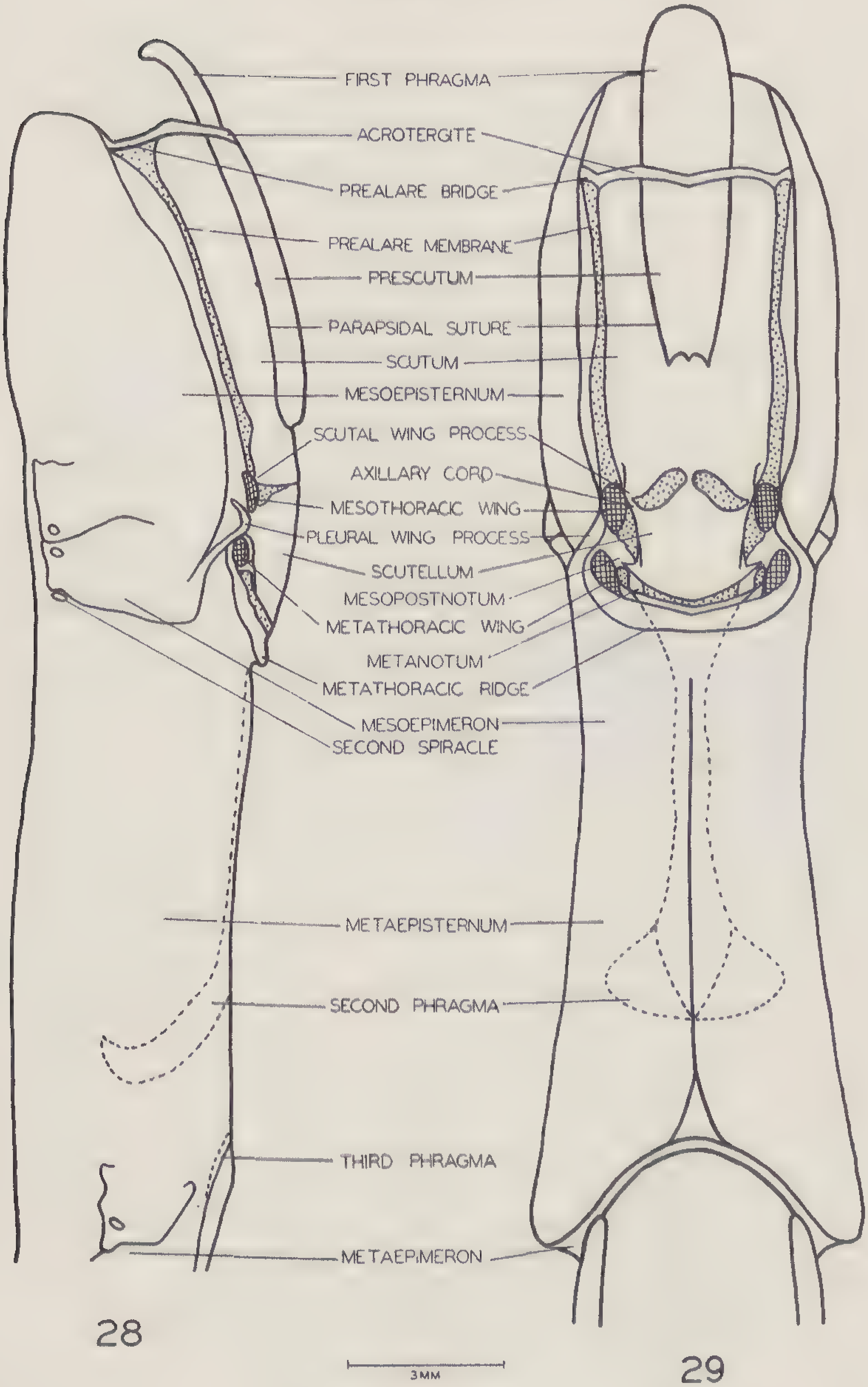
PLATE V

FIG. 28. Pterothorax of winged adult in lateral view.
FIG. 29. Pterothorax of winged adult in dorsal view.

PLATE V


FIRST PHRAGMA
ACROTERGITE
PREALARE BRIDGE
PREALARE MEMBRANE
PRESCUTUM
PARAPSIDAL SUTURE
SCUTUM
MESOEPISTERNUM
SCUTAL WING PROCESS
AXILLARY CORD
MESOTHORACIC WING
PLEURAL WING PROCESS
SCUTELLUM
MESOPOSTNOTUM
METATHORACIC WING
METANOTUM
METATHORACIC RIDGE
MESOEPIMERON
SECOND SPIRACLE
METAEPISTERNUM
SECOND PHRAGMA
THIRD PHRAGMA
METAEPIMERON
3MM

28

29

PLATE VI

FIG. 30. Right prothoracic leg in median view.
FIG. 31. Right mesothoracic leg in median view.
FIG. 32. Right metathoracic leg in median view.
FIG. 33. Right mesothoracic wing.
FIG. 34. Right metathoracic wing.

PLATE VI

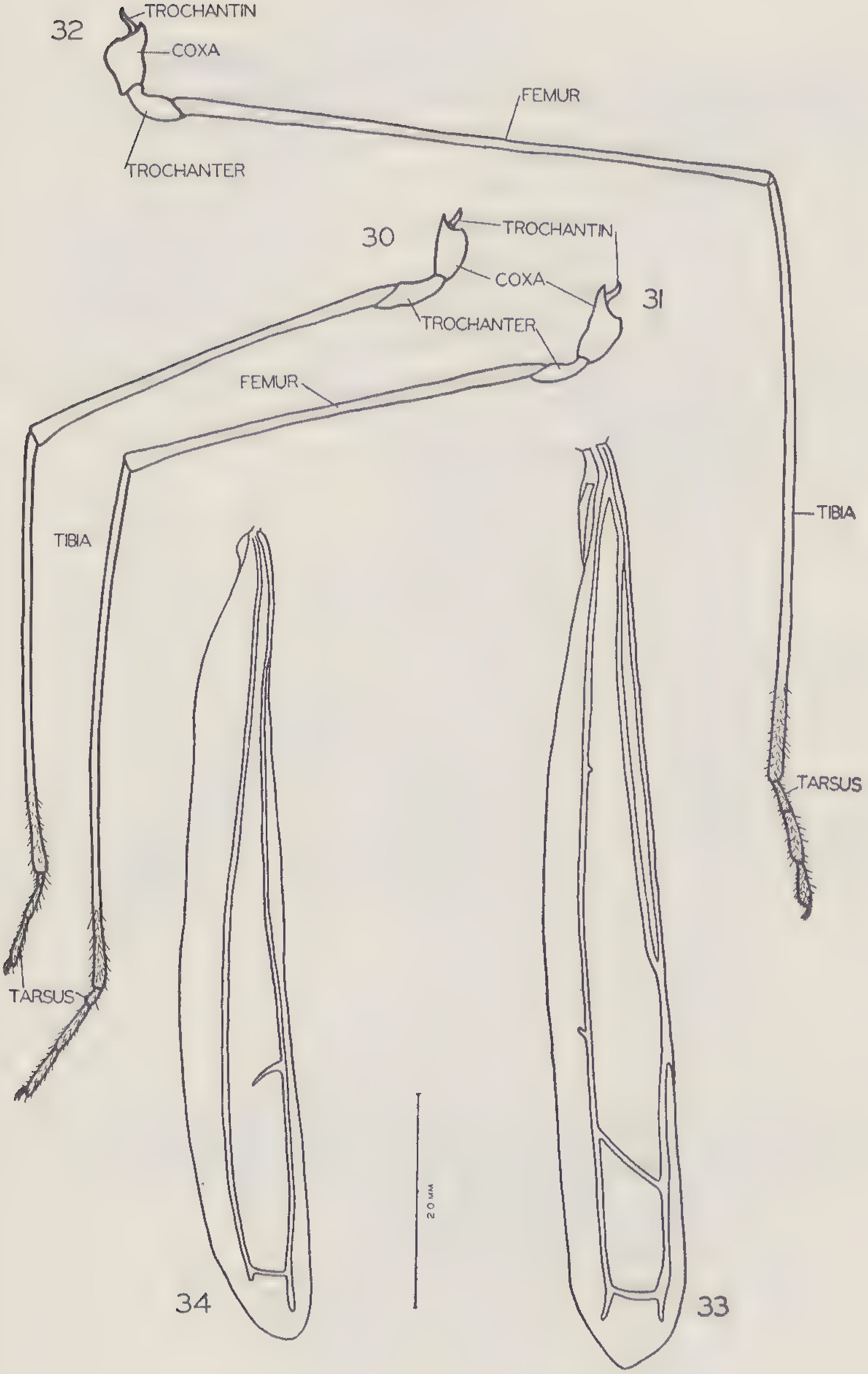

32
TROCHANTIN
COXA
FEMUR
TROCHANTER
30
TROCHANTIN
COXA
31
TROCHANTER
FEMUR
TIBIA
TIBIA
TARSUS
TARSUS
20 MM
34
33

PLATE VII

FIG. 35. Wing bases of the mesothoracic and metathoracic wings. Both wings are lifted to show the basal sclerites. Lateral view.

FIG. 36. Prothoracic muscles of the head. Base of the head and muscles of the right side in lateral view.

M 1. M. pronoti primus.
M 2. M. pronoti secundus.
M 3. M. pronoti tertius.
M 6. M. prosterni primus.
M 7. M. prosterni secundus.
M 10. M. proepisterno-postoccipitalis.

FIG. 37. Lateral view of the coxa and trochanter of the right prothoracic leg showing notal and pleural muscles.

M 13. M. noto-trochantinalis.
M 14. M. noto-coxalis primus.
M 16. M. noto-coxalis tertius.
M 17. M. pleura-coxalis.
M 20. M. noto-trochanteralis.
M 21. M. pleura-trochanteralis.

FIG. 38. Lateral view of the coxa and trochanter of the right mesothoracic leg showing notal and pleural muscles.

M 40. M. noto-trochantinalis.
M 41. M. noto-coxalis.
M 42. M. episterno-coxalis.
M 46. M. noto-trochanteralis.
M 47. M. pleura-trochanteralis.

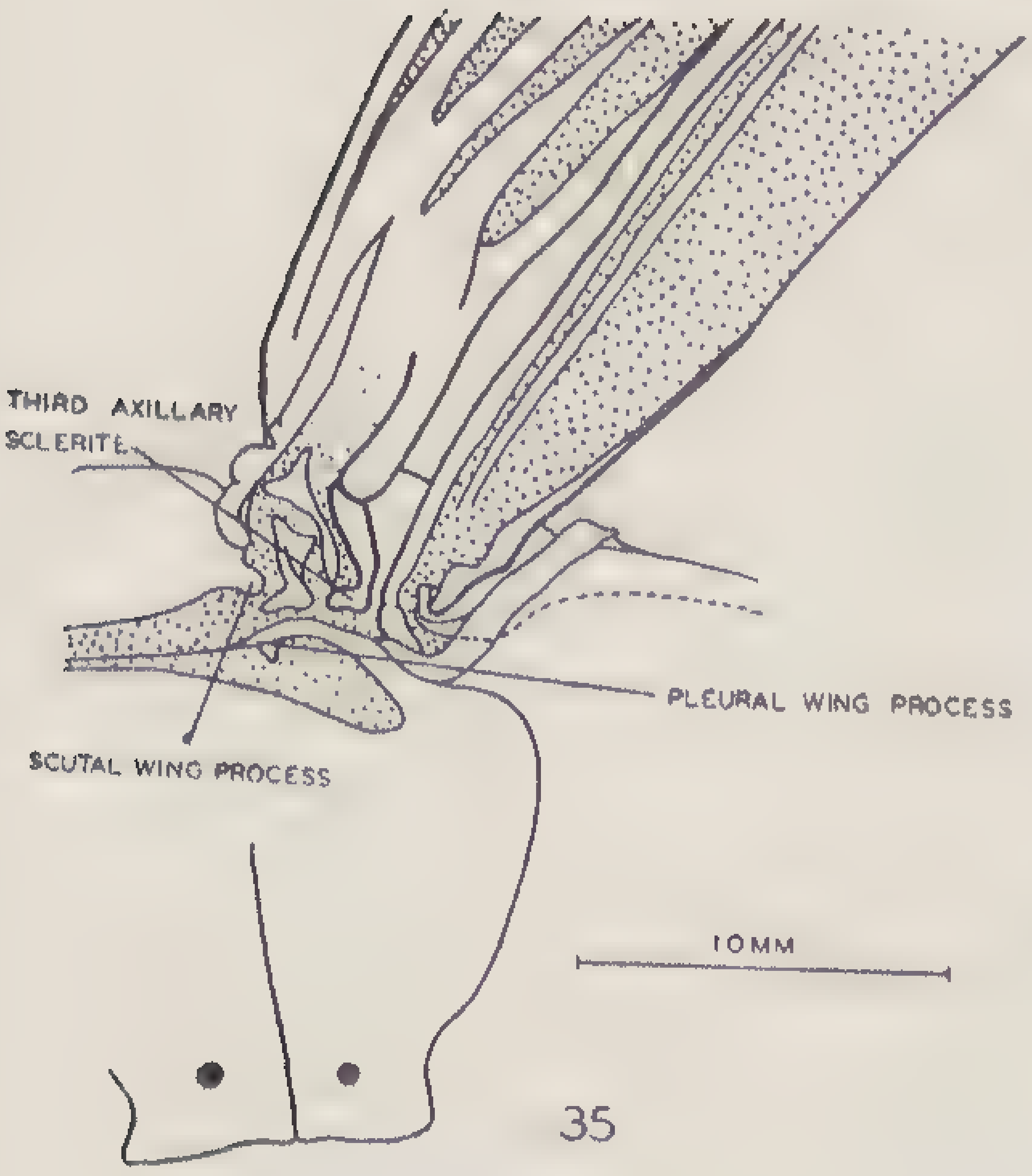
FIG. 39. Lateral view of the coxa and trochanter of the right metathoracic leg showing notal, pleural and trochanteral muscles.

M 63. M. noto-trochantinalis.
M 64. M. noto-coxalis.
M 66. M. episterno-coxalis.
M 70. M. noto-trochanteralis.
M 71. M. pleura-trochanteralis.
M 73. M. coxa-trochanteralis medialis.
M 74. M. coxa-trochanteralis lateralis.

FIG. 40. Pterothorax dissected to show the principal flight muscles of the right side. Lateral view. The leg muscles are removed.

M 30. M. mesonoti-primus.
M 34. M. dorso-ventralis primus.
M 38. M. episterno-alaris.
M 39. M. furca-pleuralis (mesothoracic).
M 57. M. metanoti-secundus.
M 62. M. furca-pleuralis (metathoracic).

PLATE VII



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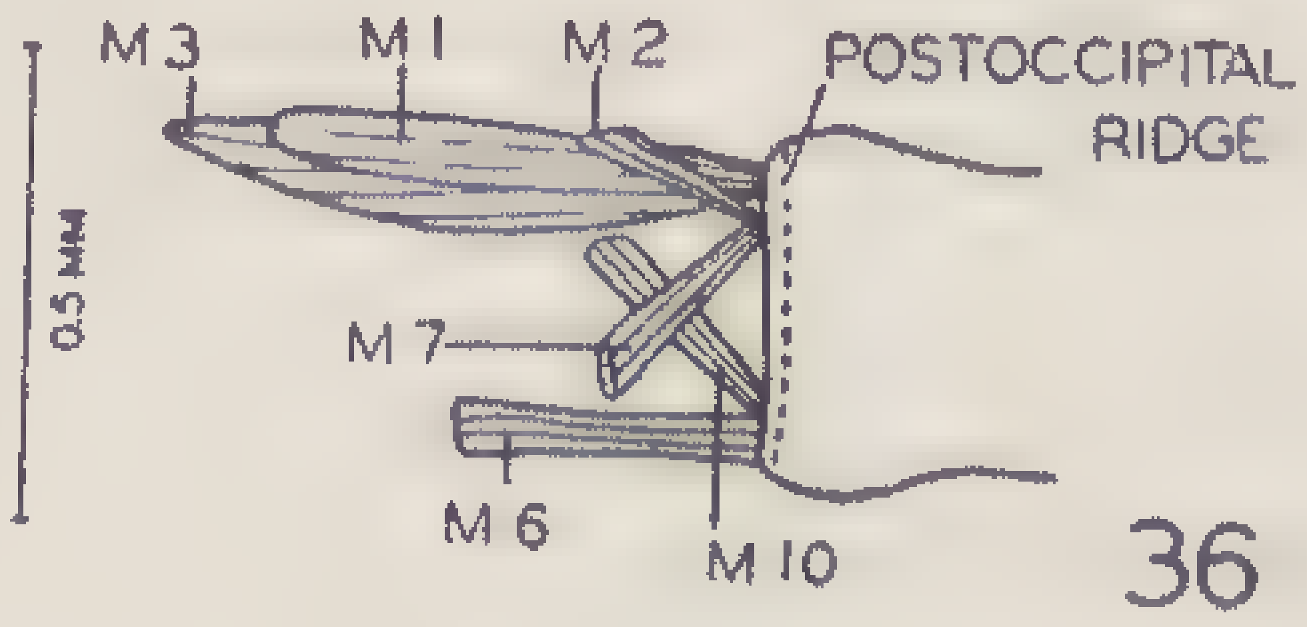

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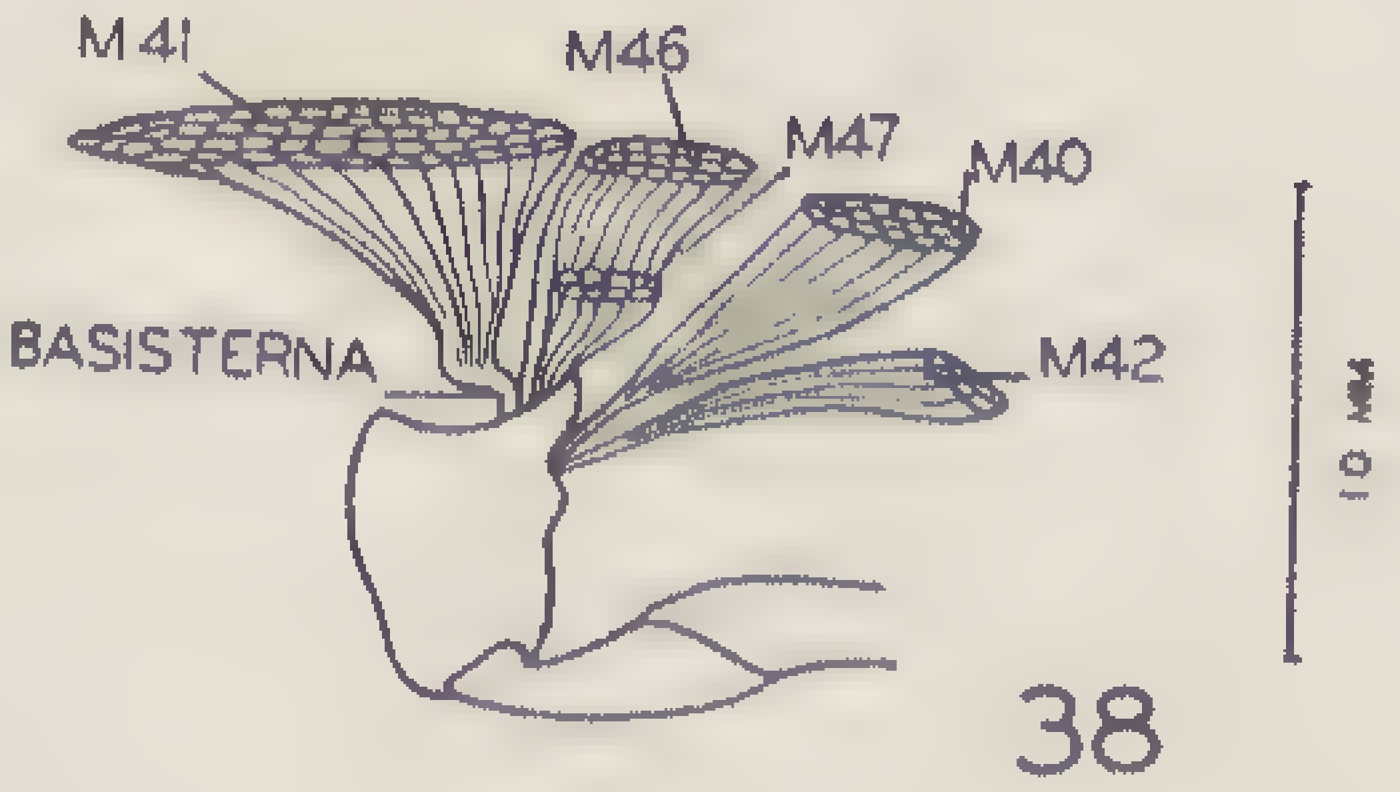

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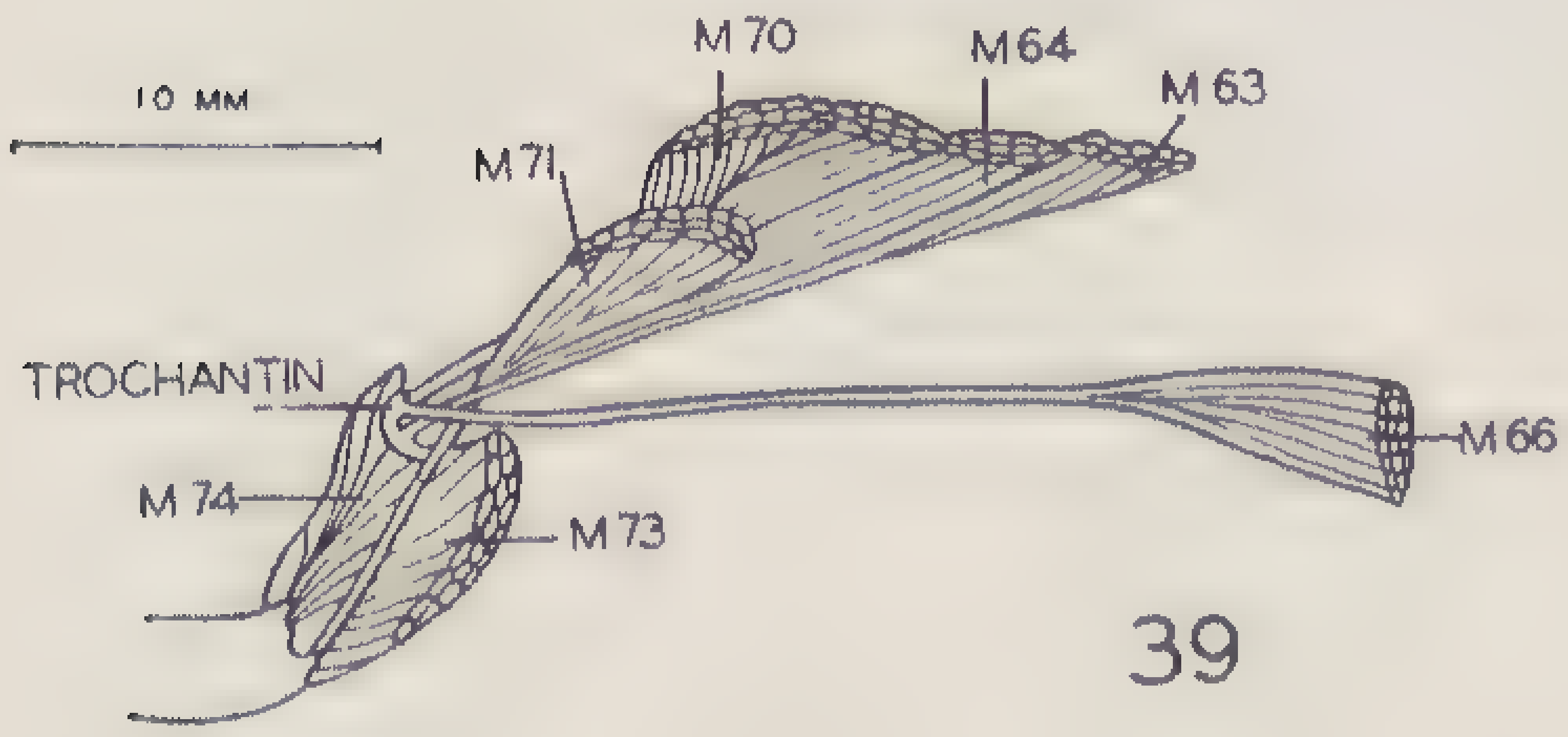

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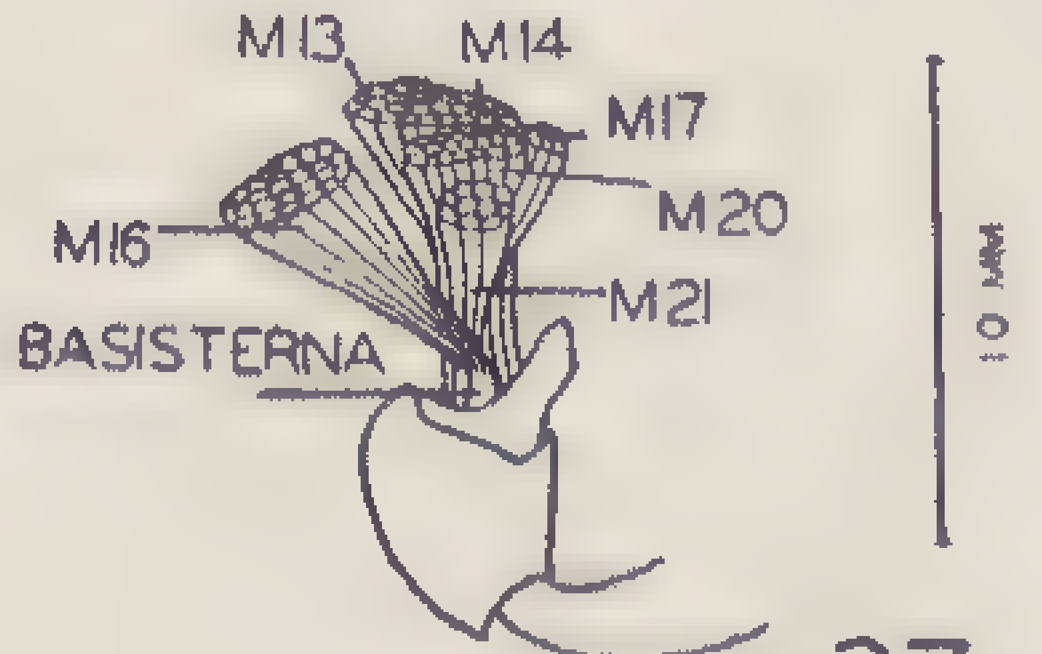

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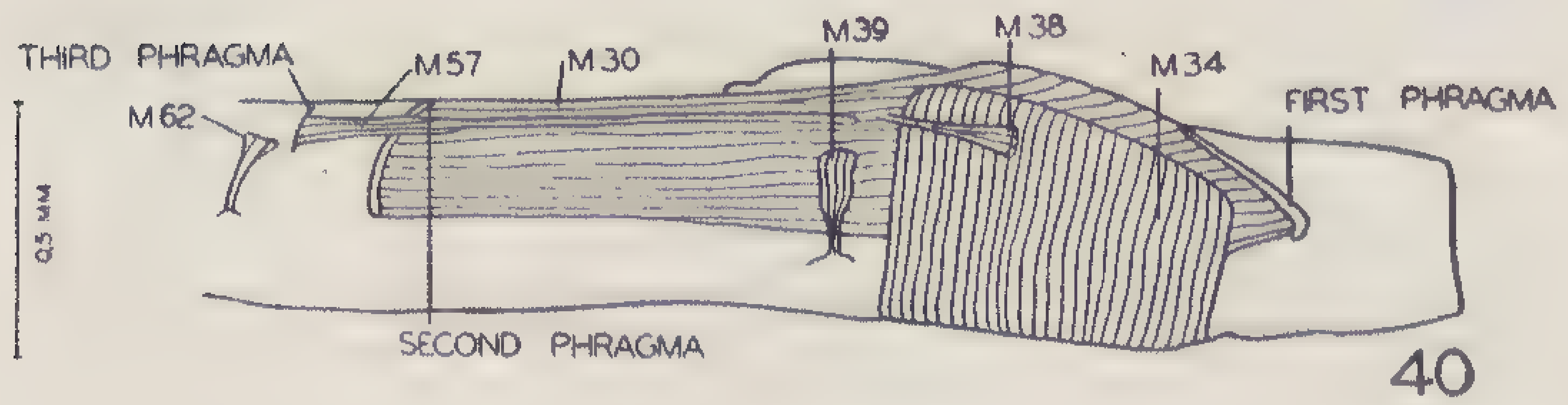
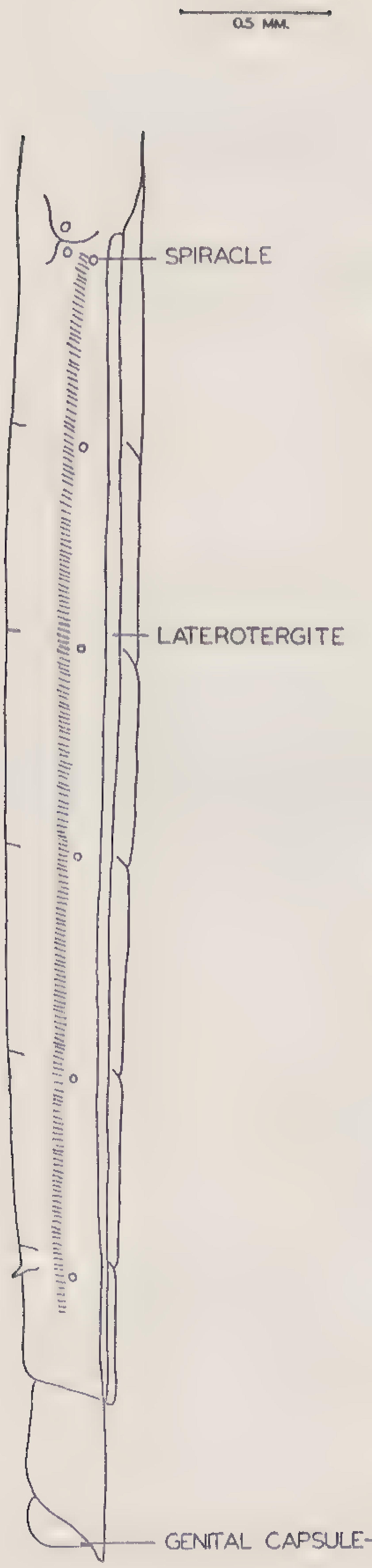


40

PLATE VIII

FIG. 41. Abdomen of adult male. Lateral view of left side.
FIG. 42. Abdomen of adult male. Dorsal view.
FIG. 43. Abdomen of adult female. Dorsal view.

PLATE VIII



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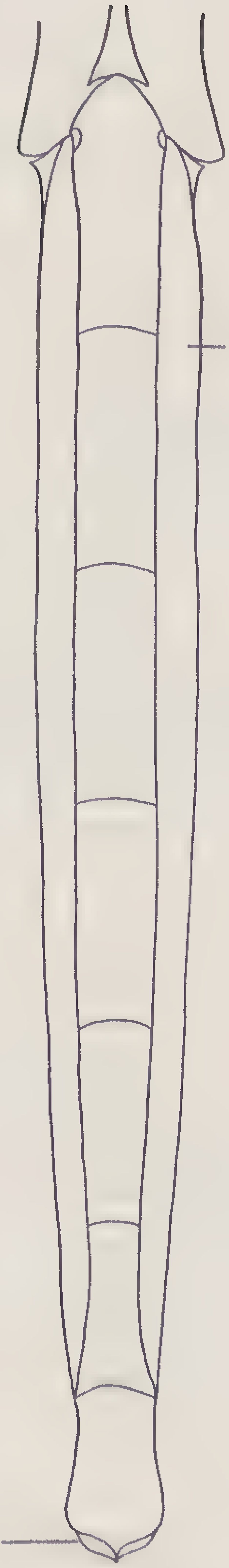

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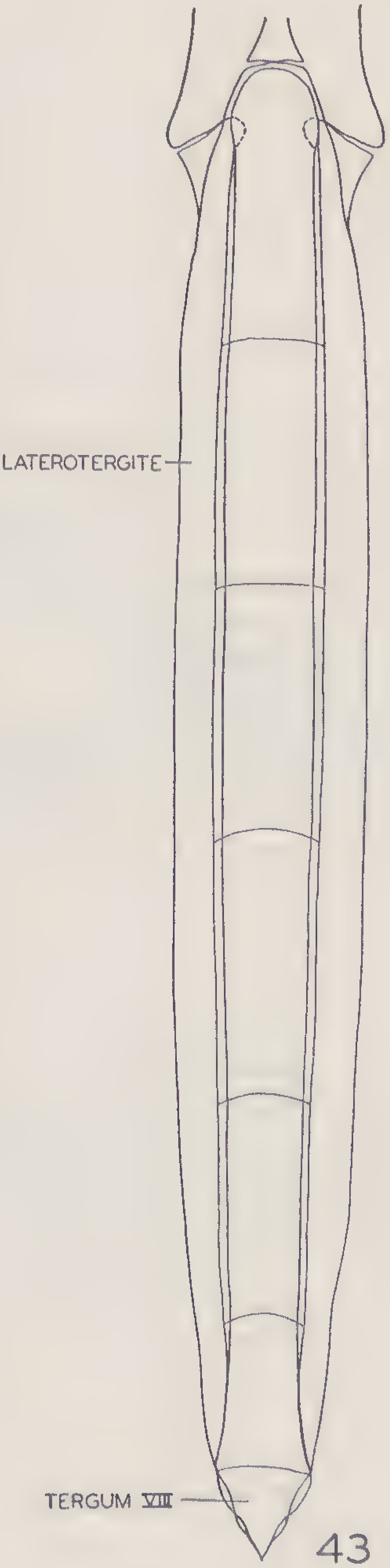


43

PLATE IX

TERMINAL SEGMENTS OF THE ADULT FEMALE

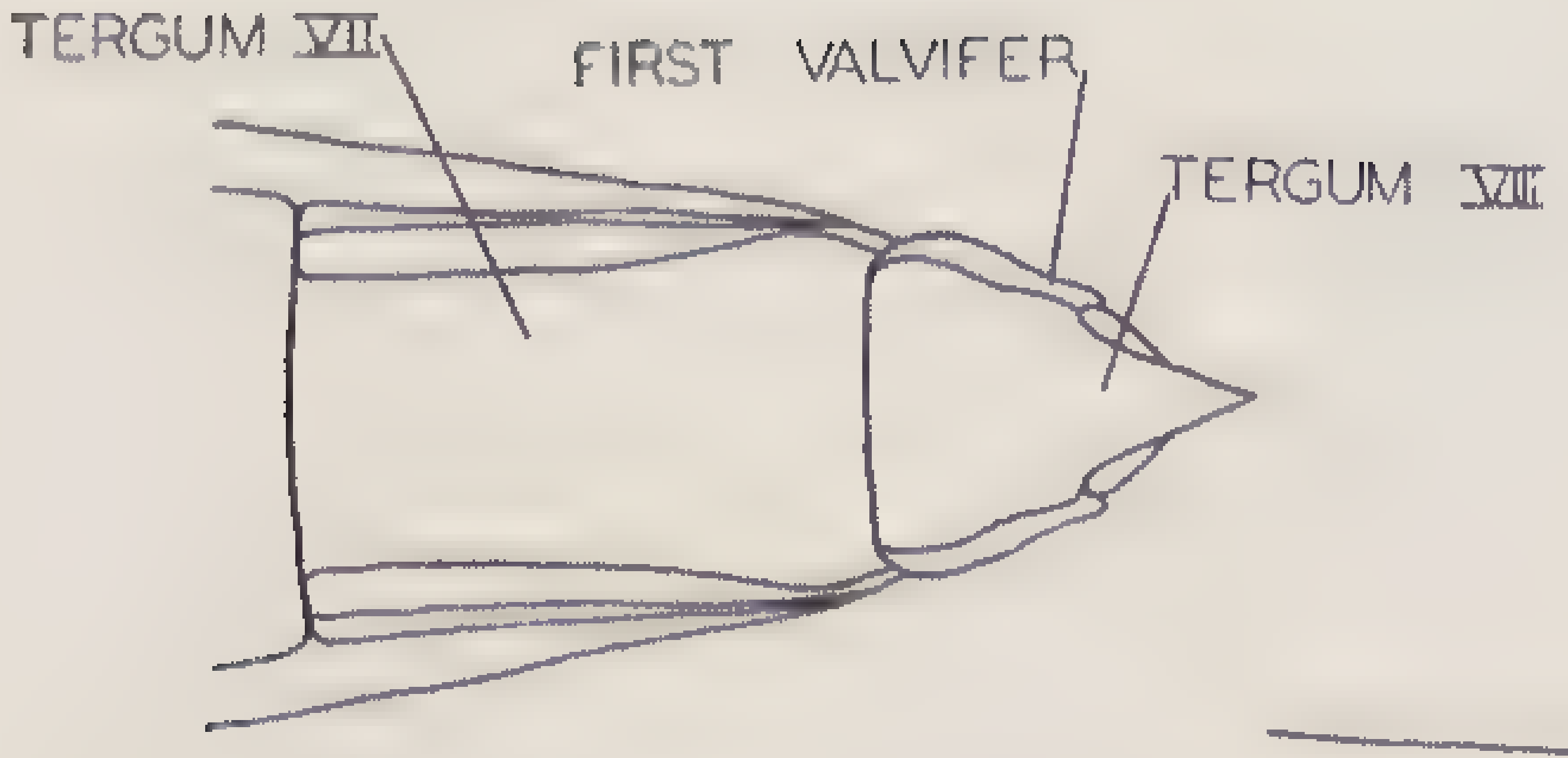
FIG. 44. Dorsal view.

FIG. 45. Ventral view.

FIG. 46. Lateral view.

FIG. 47. Lateral view. Left half of exoskeleton of the seventh segment and the left parasternite of the eighth segment have been removed to expose the genitalia and the musculature of the region. (Diagrammatic.)

PLATE IX



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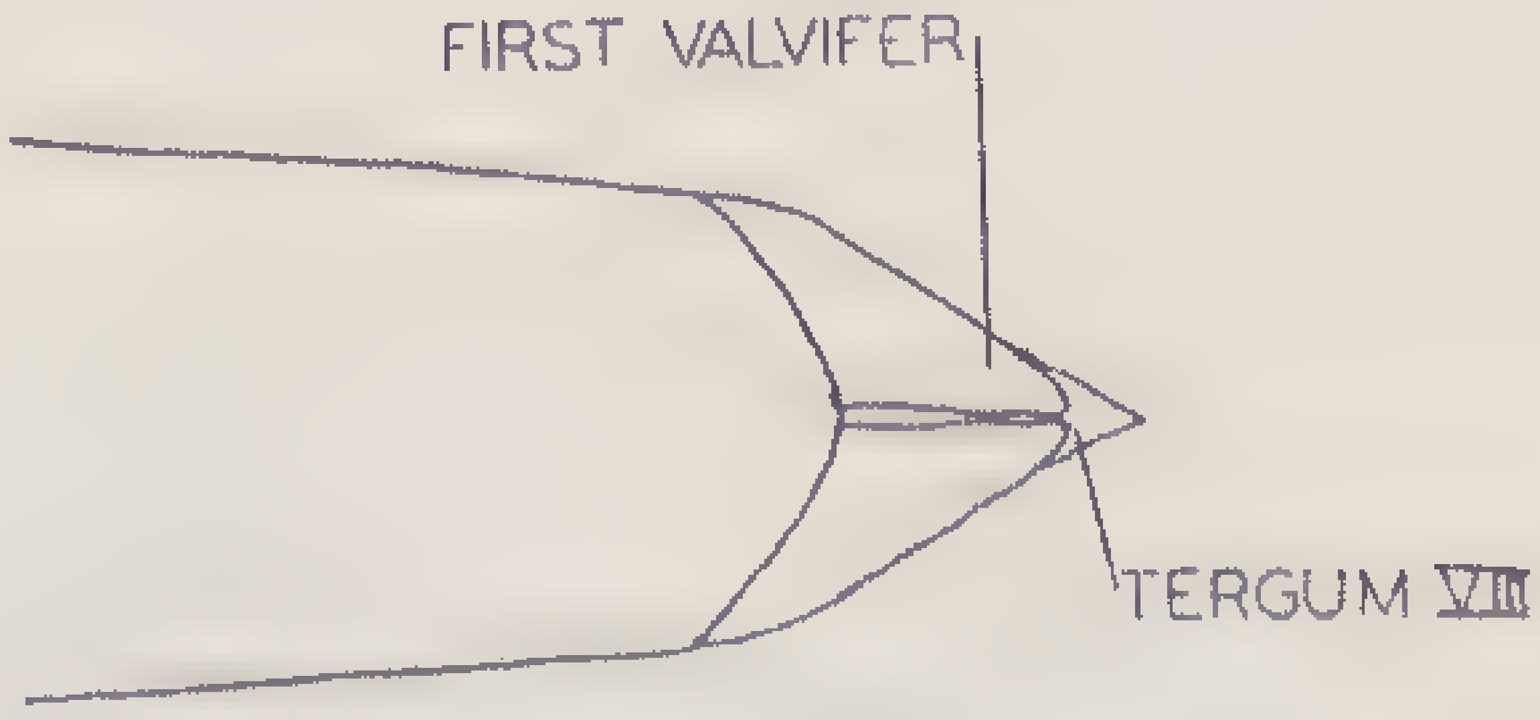

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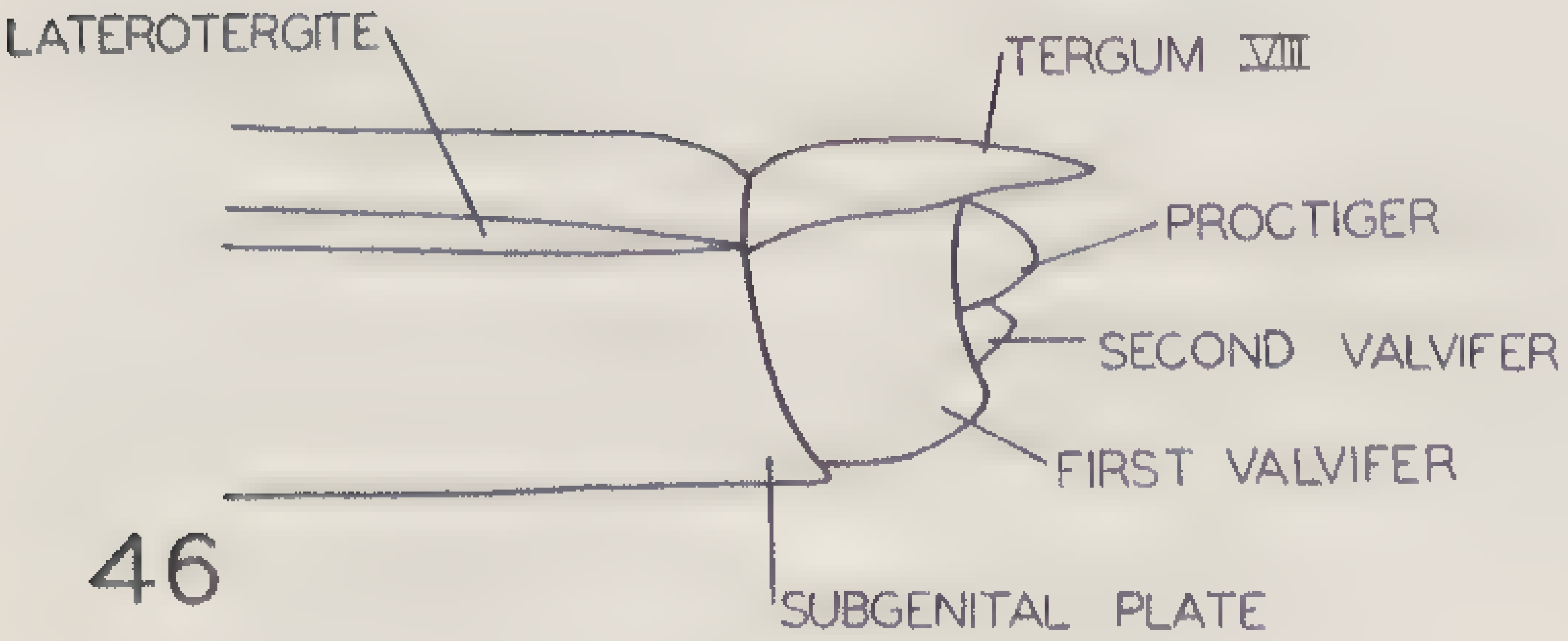

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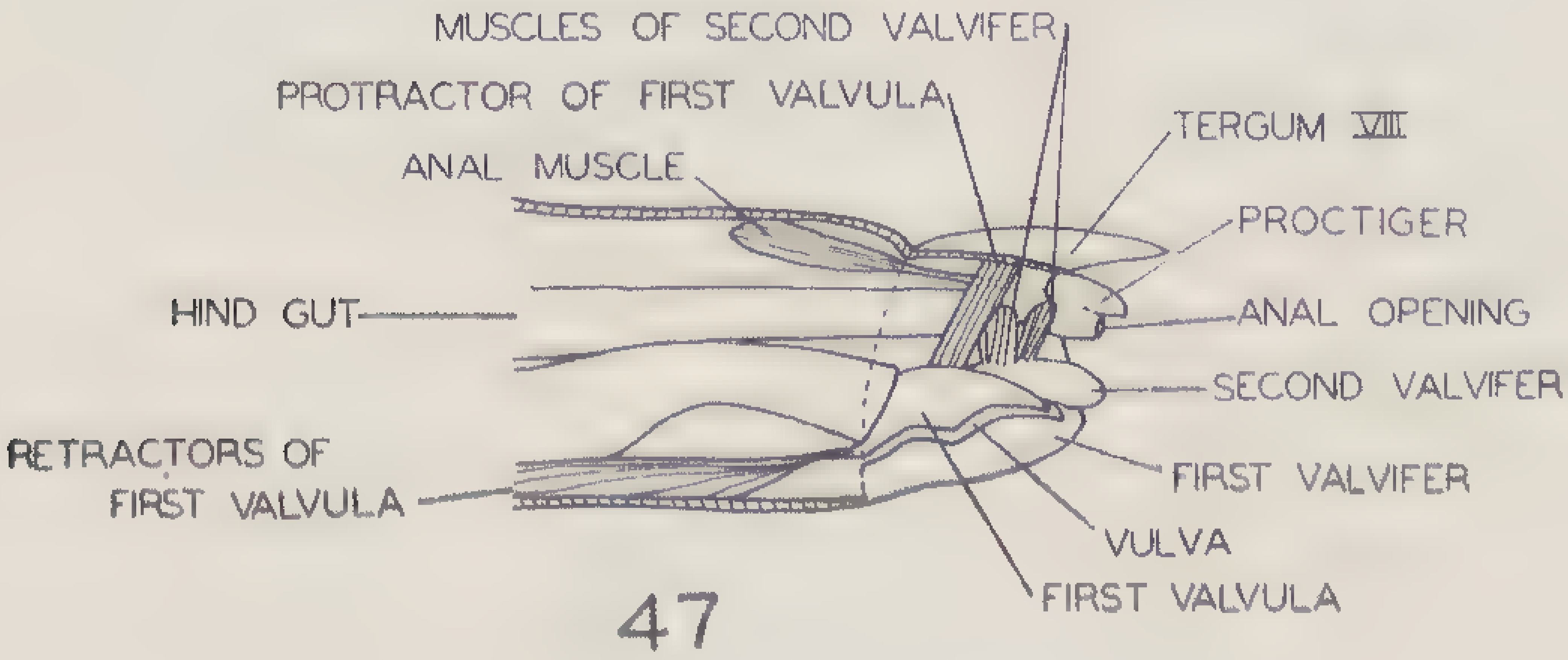


47

PLATE X

TERMINAL SEGMENTS OF THE ADULT MALE

FIG. 48. Lateral view of the left side. The eighth segment is deflected ventrally.

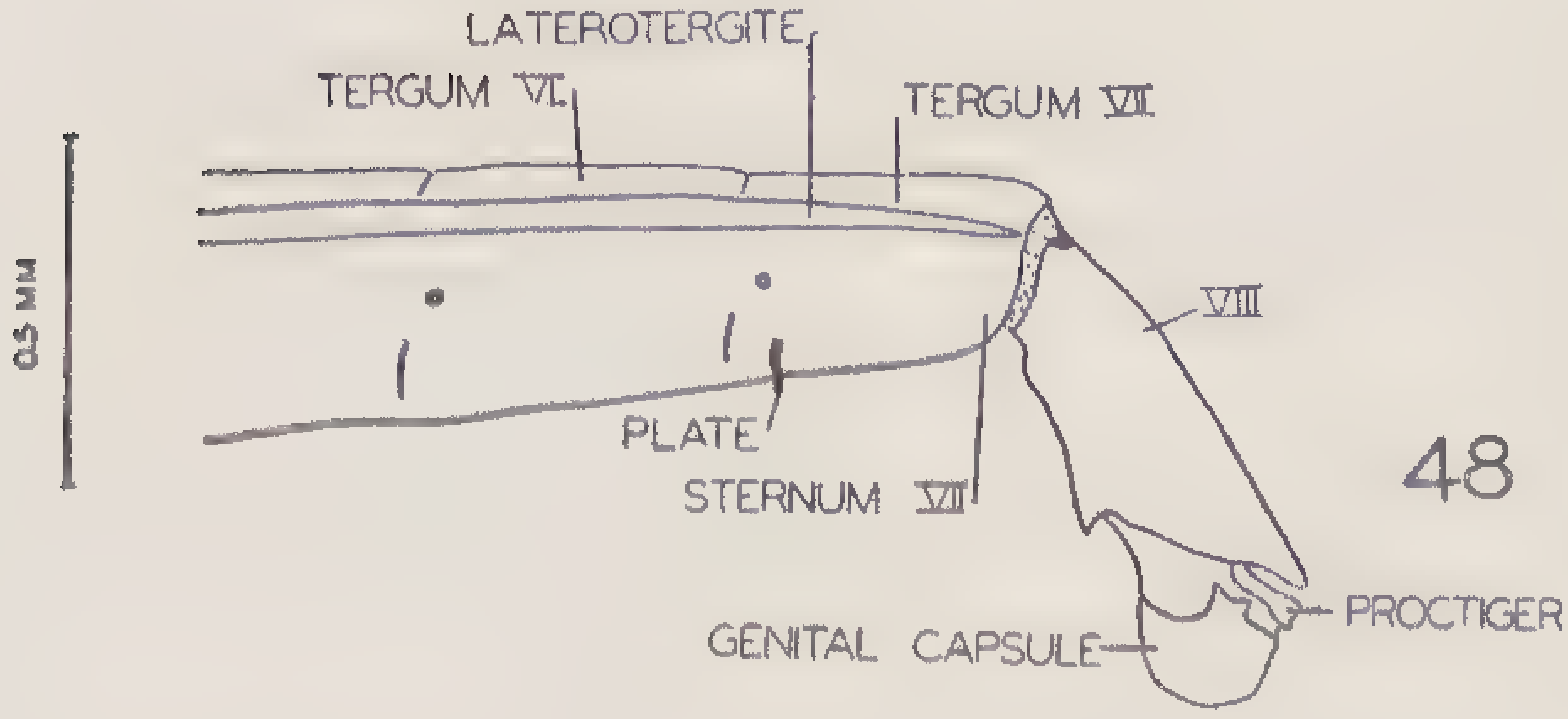
FIG. 49. Genital capsule in lateral view. The left side of the capsule is removed to demonstrate the muscles of the basal plate and the parameres. The proctiger and the phallobase are partially protracted.

FIG. 50. Dorsal view of the ninth segment.

FIG. 51. Dorsal view of the ninth segment, the proctiger removed.

FIG. 52. Lateral view of the ninth segment, with the intromittent apparatus everted.

PLATE X



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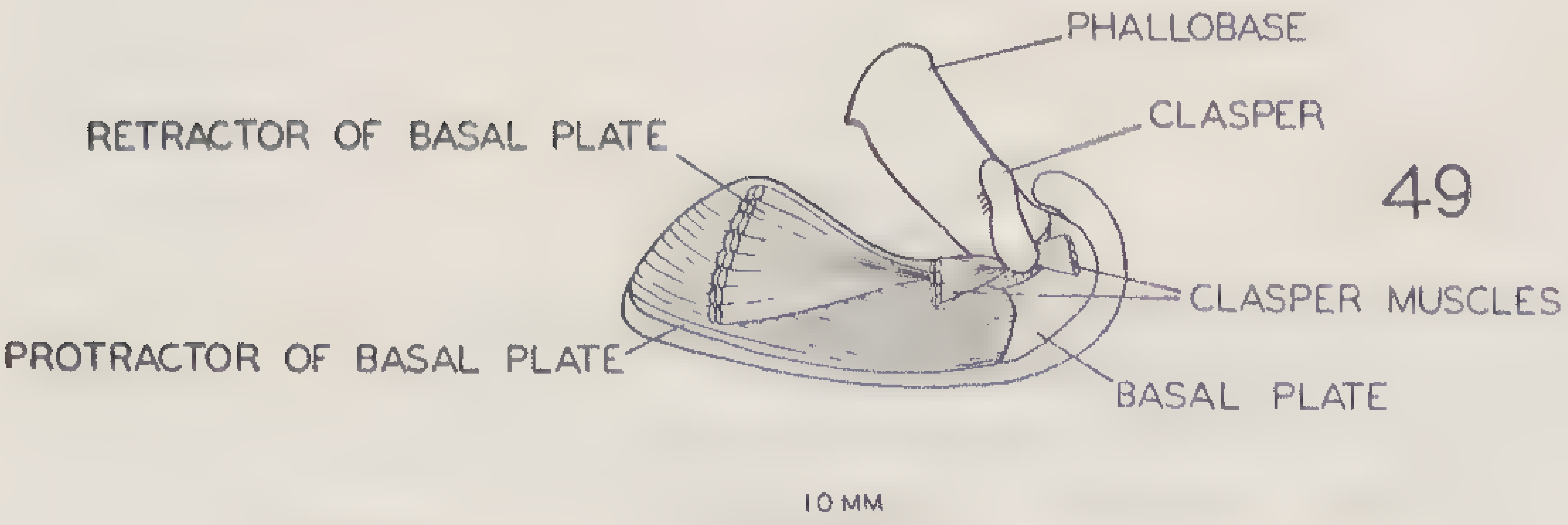

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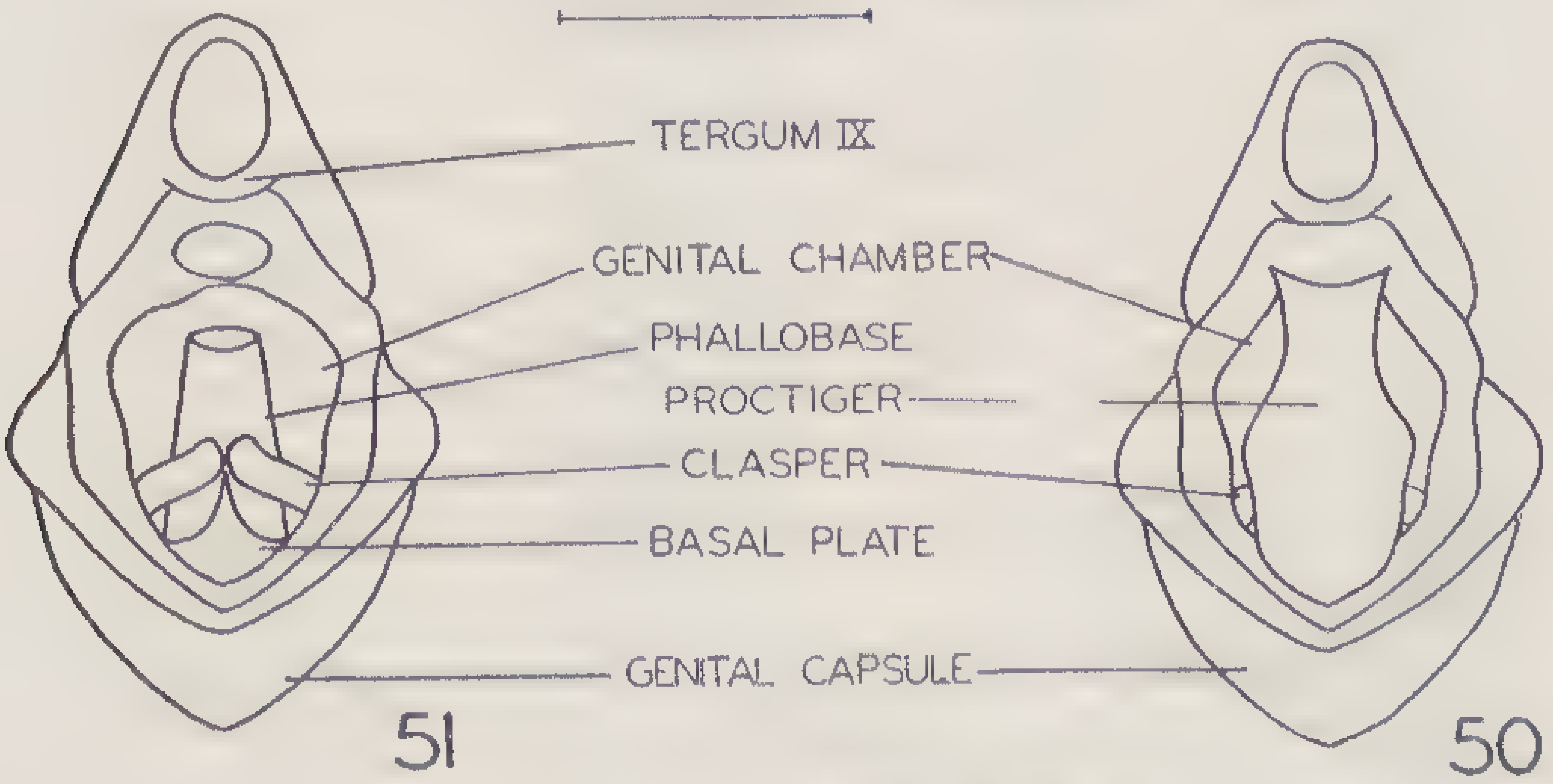

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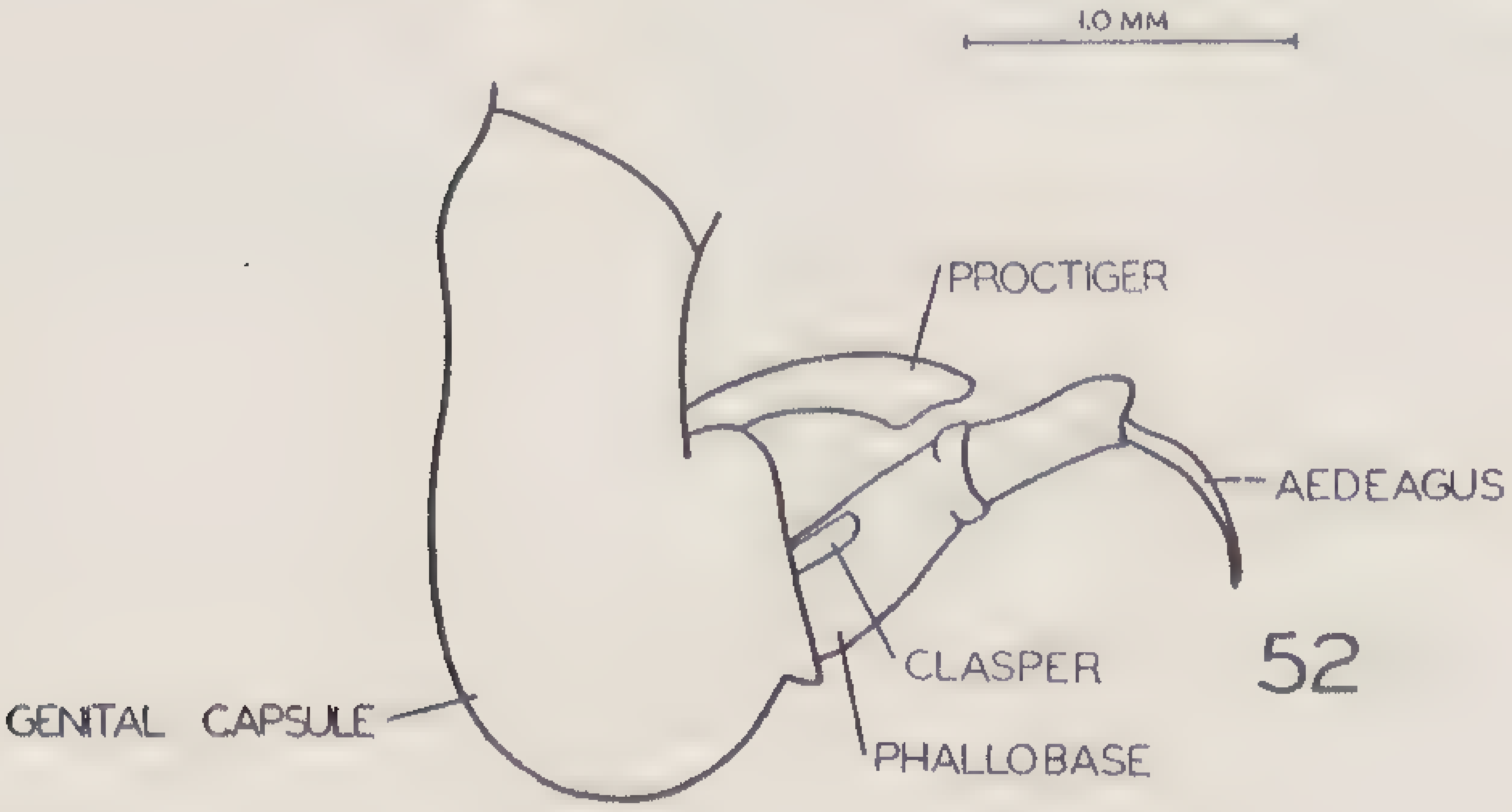
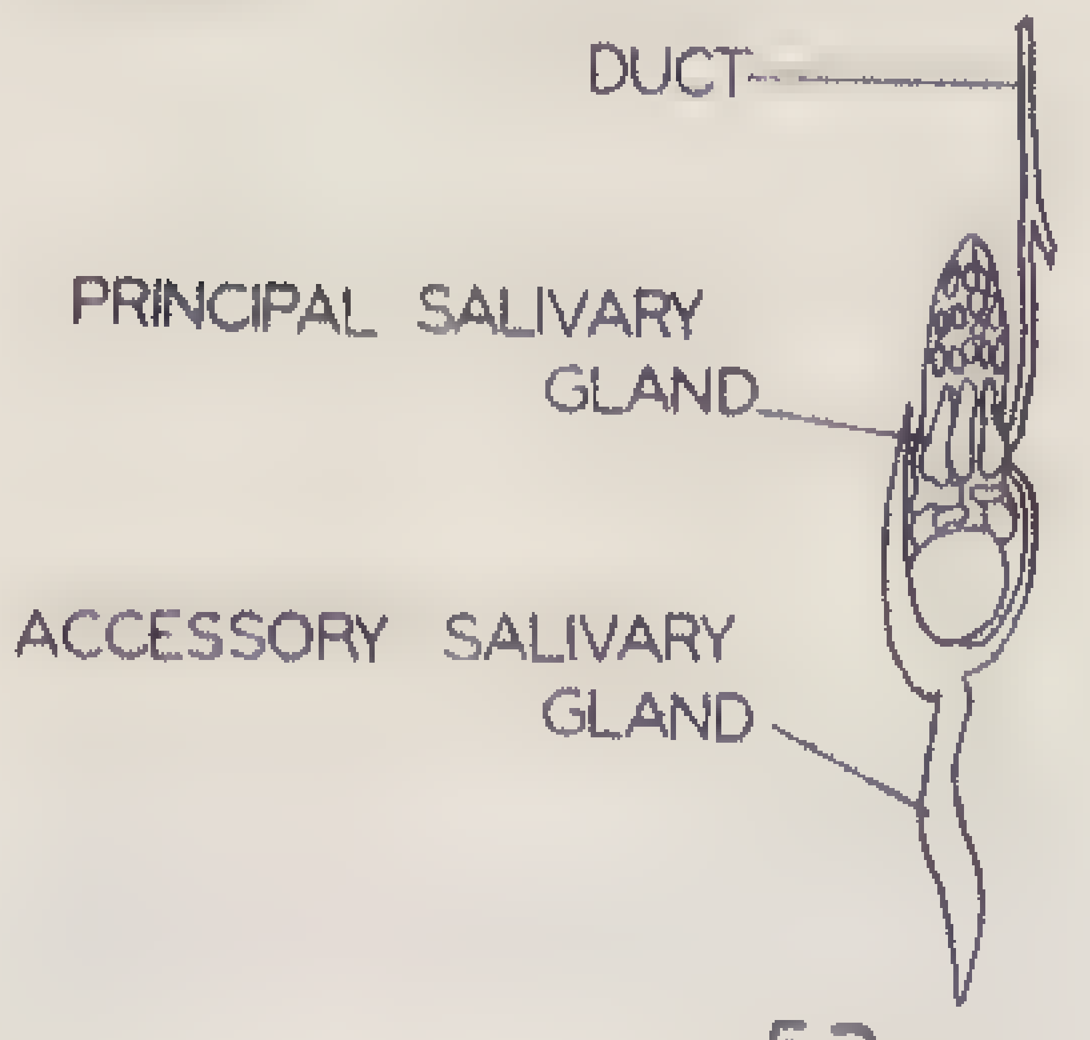


52

PLATE XI

FIG. 53. Salivary glands of the left side in dorsal view.
FIG. 54. Digestive system in dorsal view.
FIG. 55. Female reproductive system in dorsal view.
FIG. 56. Male reproductive system in dorsal view.

PLATE XI



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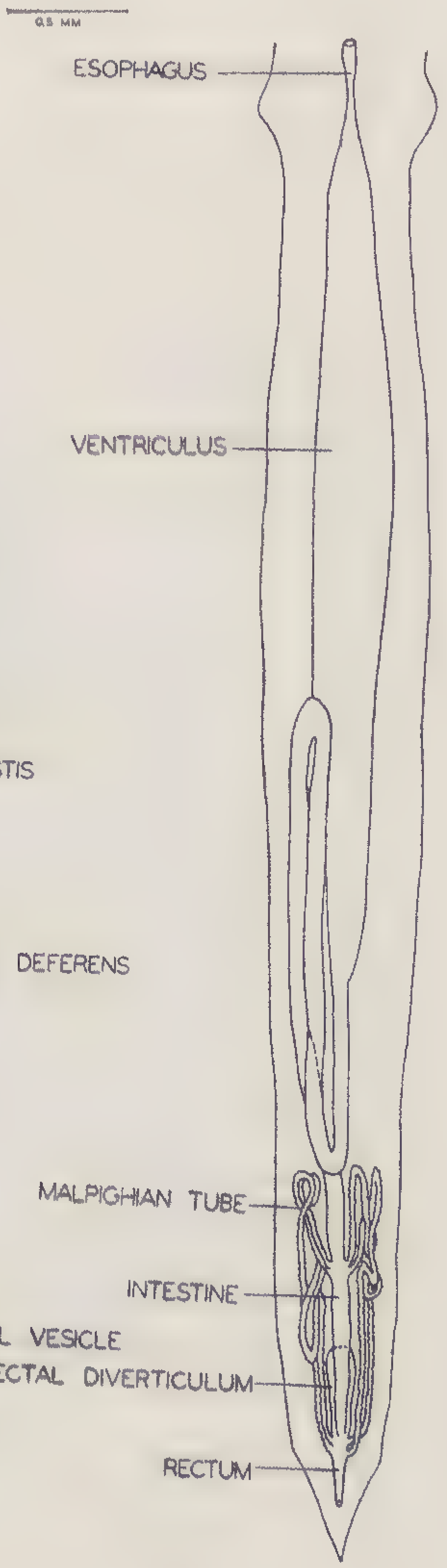

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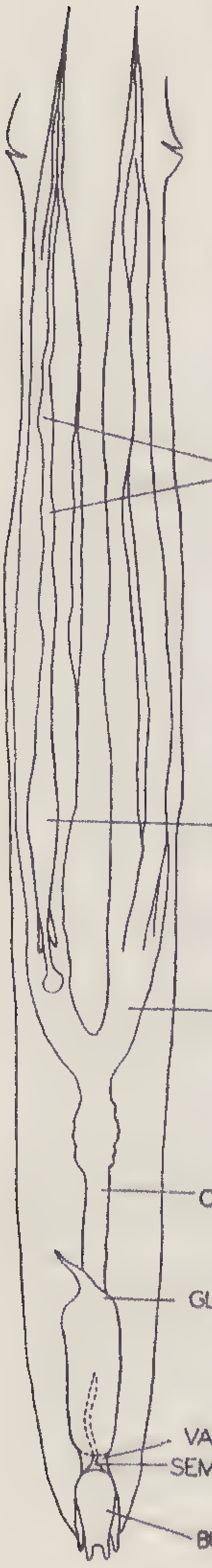

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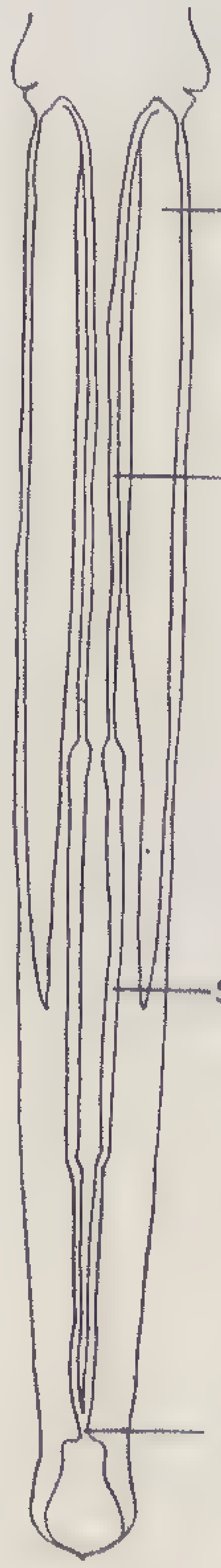


56

PLATE XII

FIG. 57. External view of an egg of *Hydrometra martini*, showing the sculpturing of the exochorion.

FIG. 58. Cleared egg, showing the endochorion, micropylar tube and basal spicule.

FIG. 59. Cross section through the basal region of the egg, above the basal disc.

FIG. 60. Cross section through the apical region of the egg, below the micropyle.

SERIES OF DIAGRAMS SHOWING THE DEVELOPMENT OF LIVING EGGS FROM THE SIXTH THROUGH THE ELEVENTH DAY OF INCUBATION AT 25°

FIG. 61. Egg showing the position of the eyes at 9:30 and 10:30 AM on the sixth day of incubation.

FIG. 62. Egg showing the position of the eyes at 11:30 AM on the sixth day of incubation.

FIG. 63. Egg showing the position of the eyes at 12:00 noon on the sixth day of incubation.

FIG. 64. Egg showing the position of the eyes at 12:15 and 12:45 on the sixth day of incubation.

FIG. 65. Egg showing the development on the seventh day of incubation.

FIG. 66. Egg showing the development on the eighth day of incubation.

FIG. 67. Egg showing the development on the ninth day of incubation.

FIG. 68. Egg showing the development on the tenth day of incubation.

FIG. 69. Egg showing the development on the eleventh day of incubation.

PLATE XII

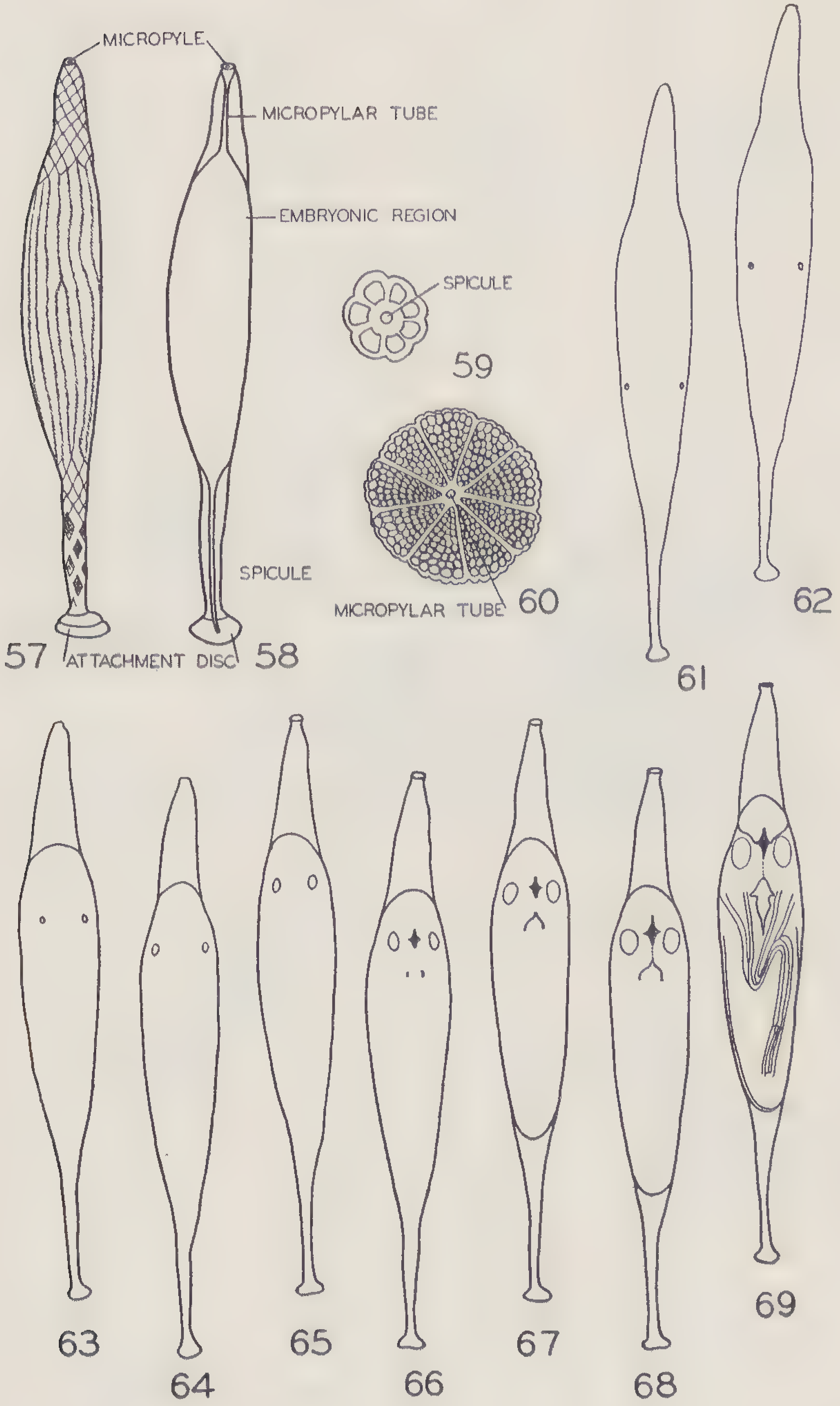
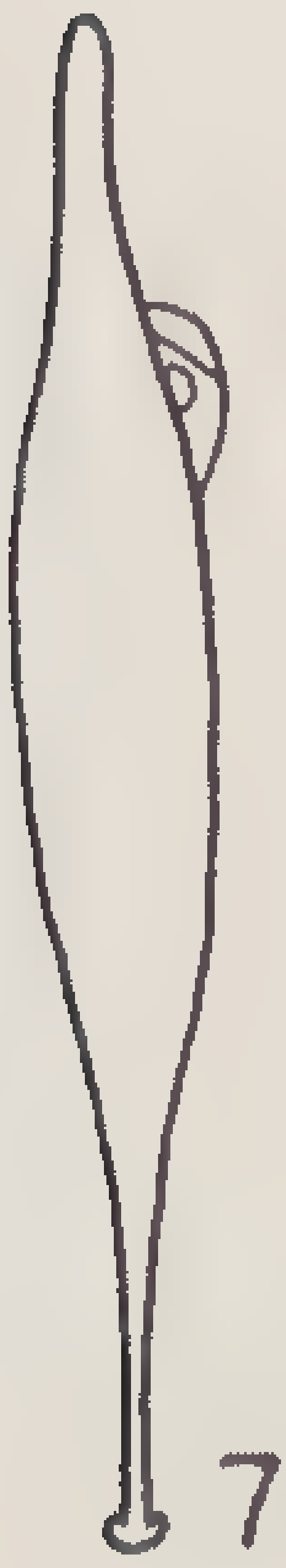

MICROPYLE
MICROPYLAR TUBE
EMBRYONIC REGION
SPICULE
SPICULE
MICROPYLAR TUBE
ATTACHMENT DISC

PLATE XIII

SERIES OF SKETCHES TO SHOW THE HATCHING PROCESS IN *Hydrometra martini*

FIG. 70. Head pushing through split in chorion; half of eyes exposed.
FIG. 71. Head exposed; eyes and labrum free of the chorion.
FIG. 72. Thorax nearly exposed.
FIG. 73. Thorax exposed.
FIG. 74. Nymph arching back, pulling legs, antennae and beak out.
FIG. 75. Nymph straightening back and flexing head.
FIG. 76. Exuviae split; beginning of "prenatal molt."
FIG. 77. "Prenatal molt" nearly complete.
FIG. 78. Nymph approaching supporting surface; antennae, beak and tip of abdomen still within exuviae.

PLATE XIII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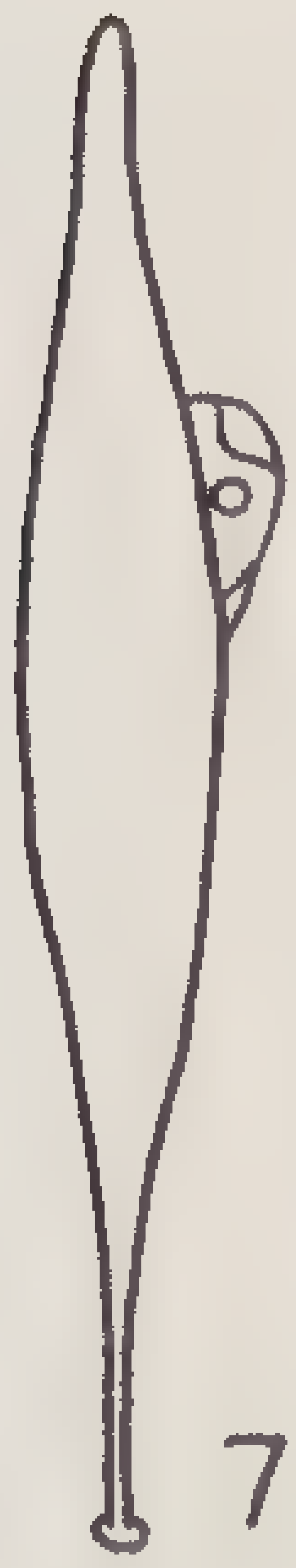
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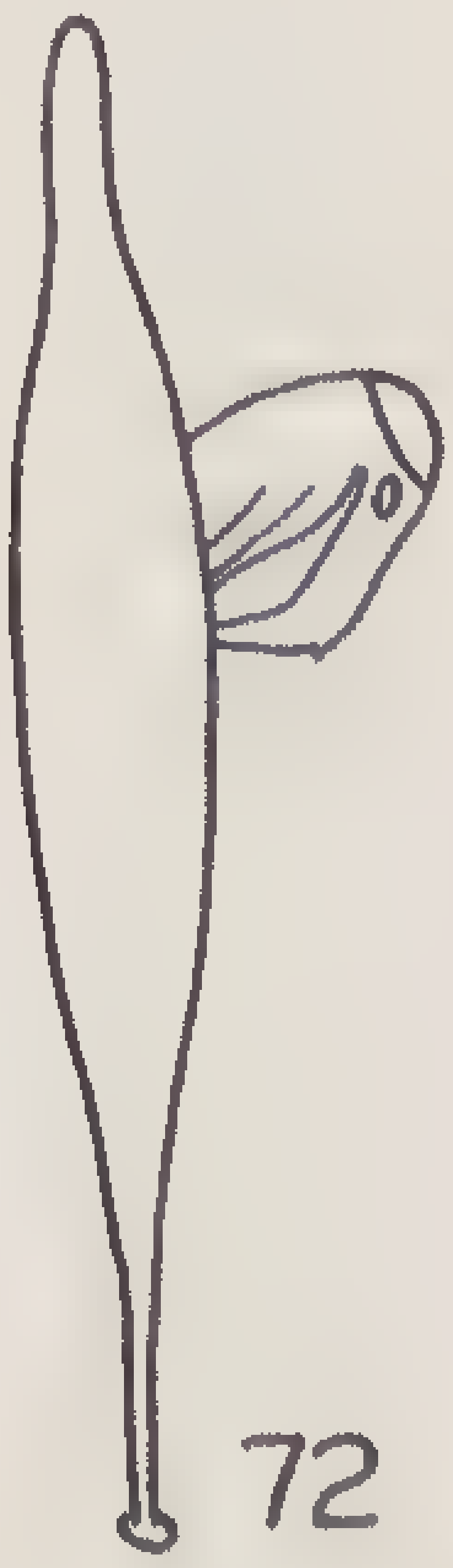
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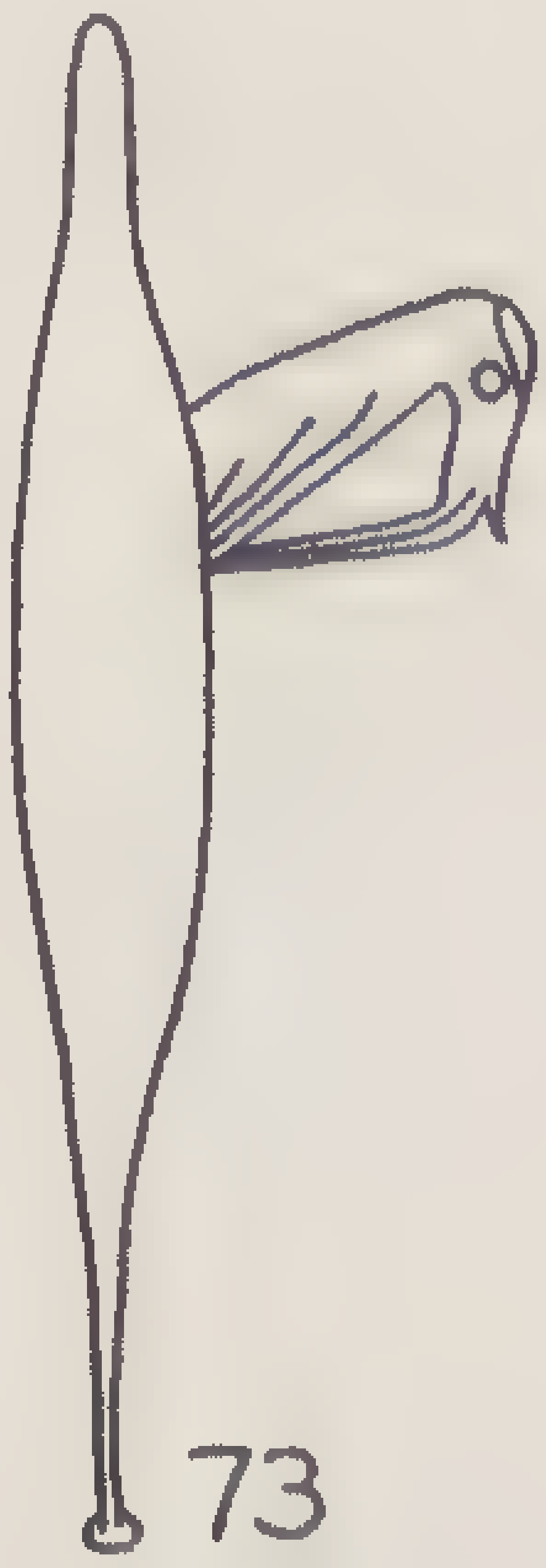
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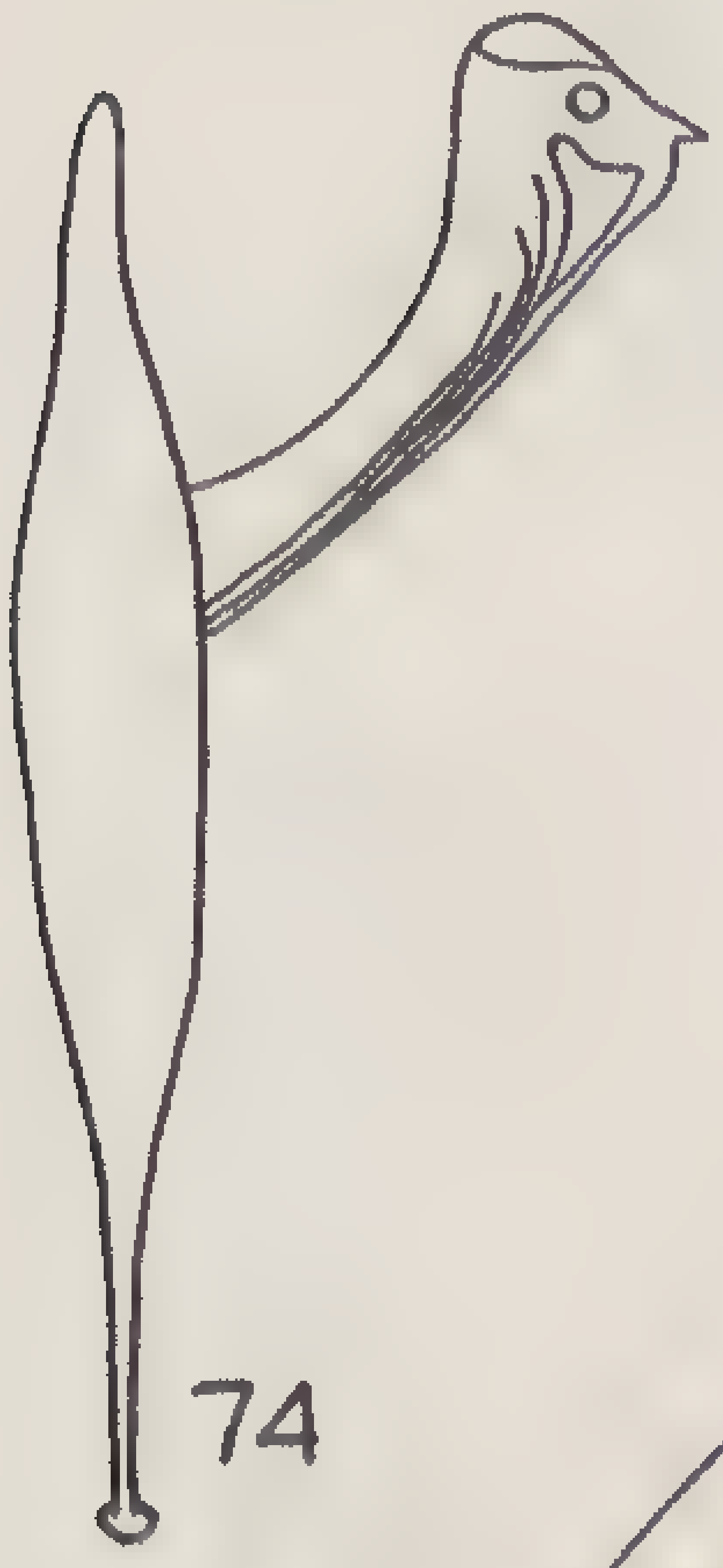
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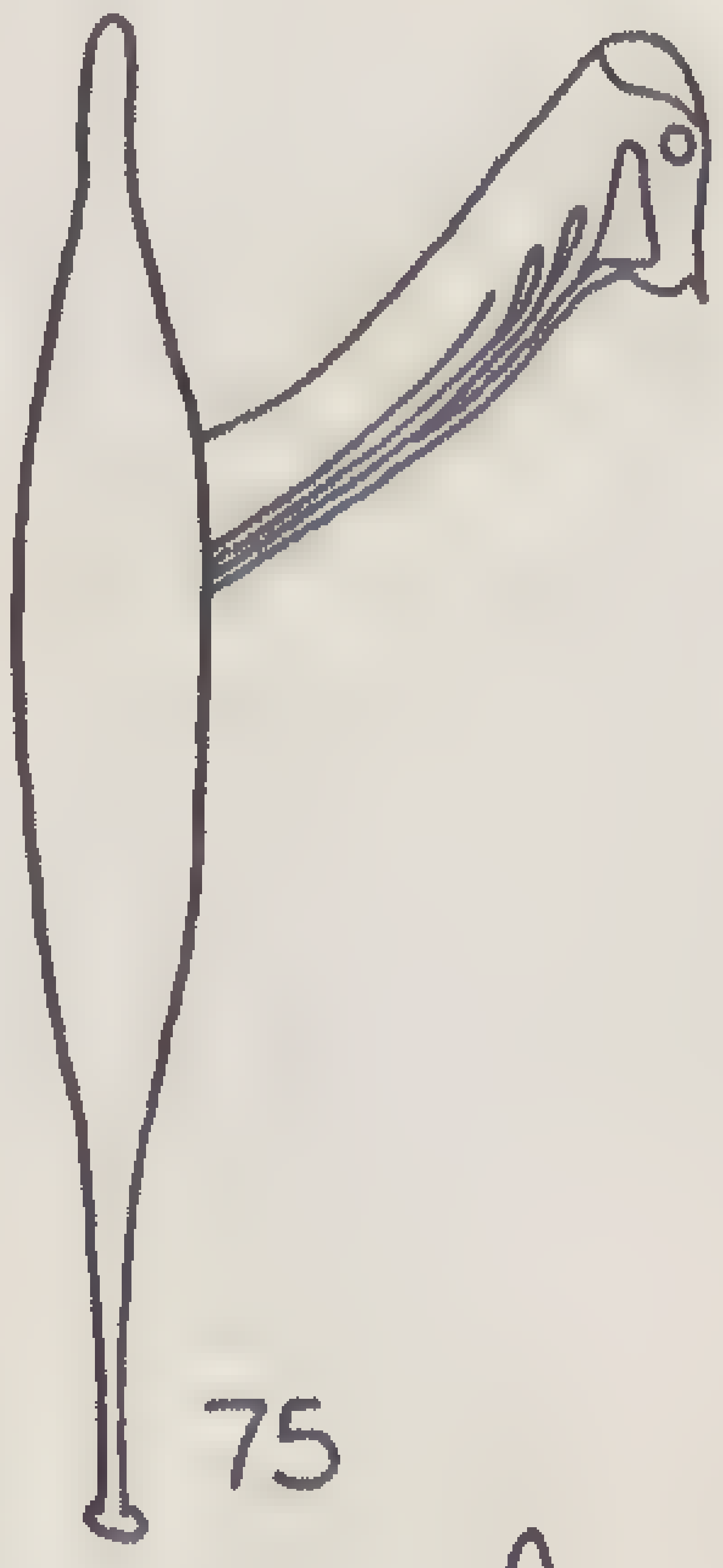
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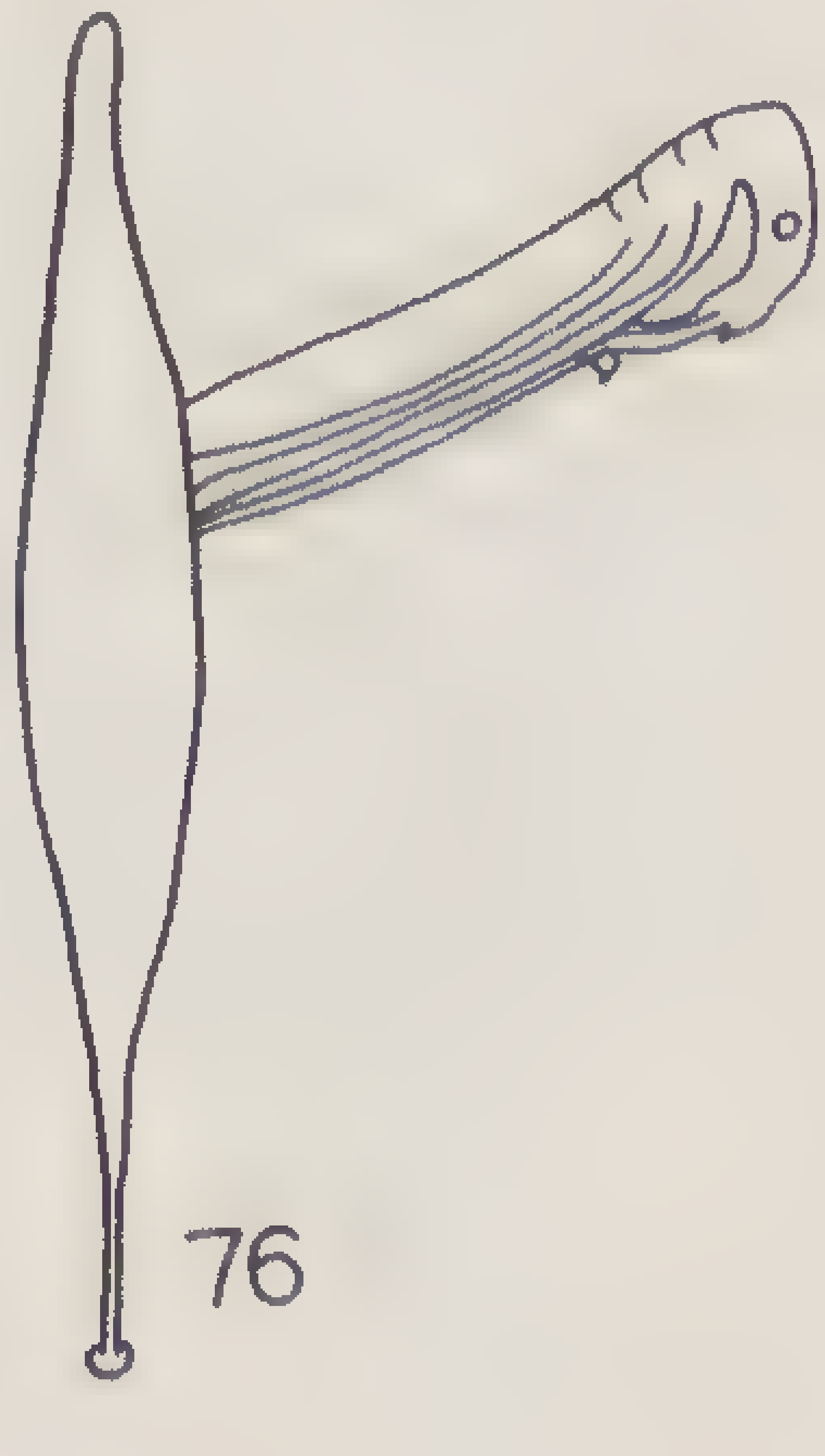
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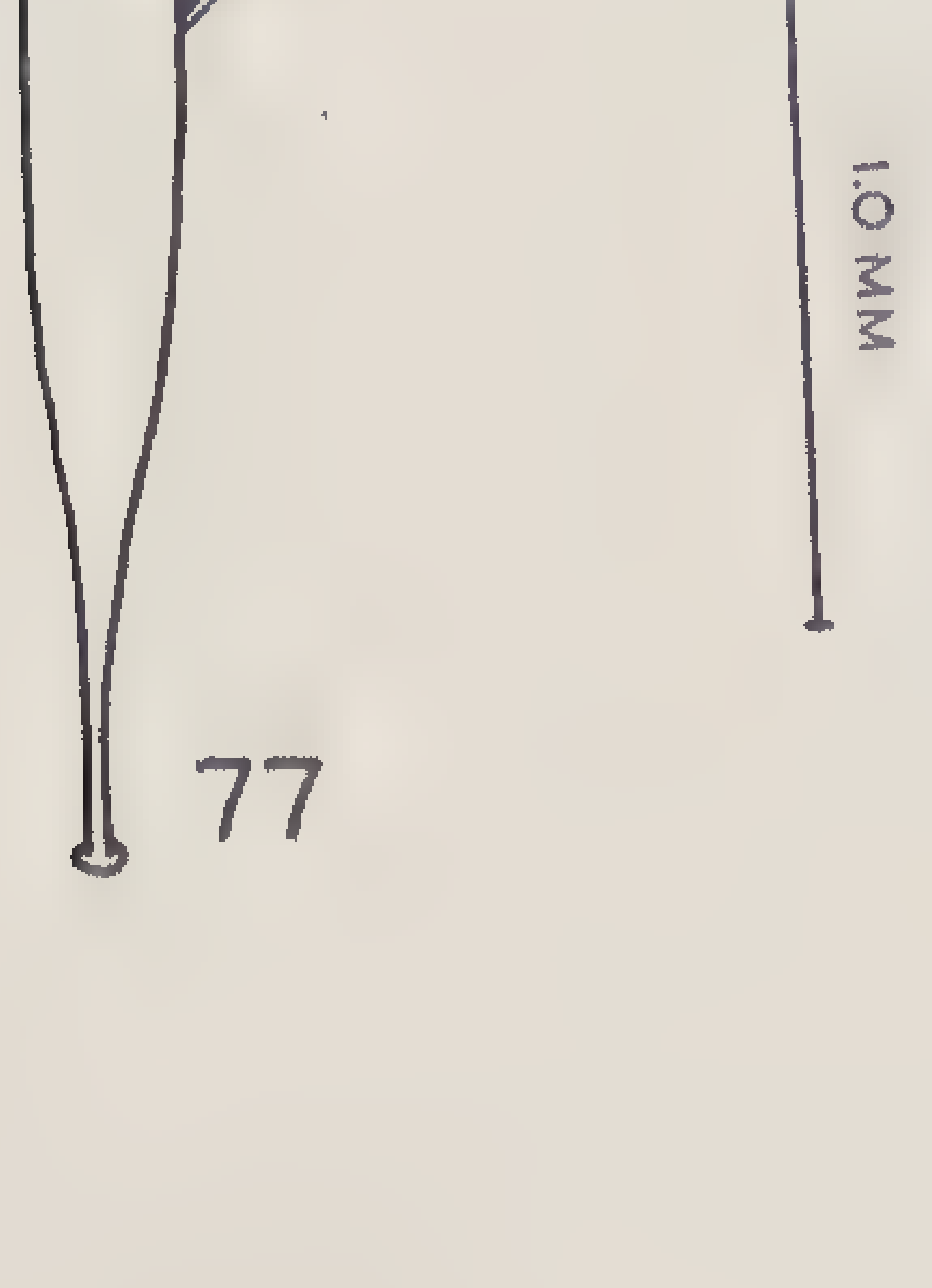

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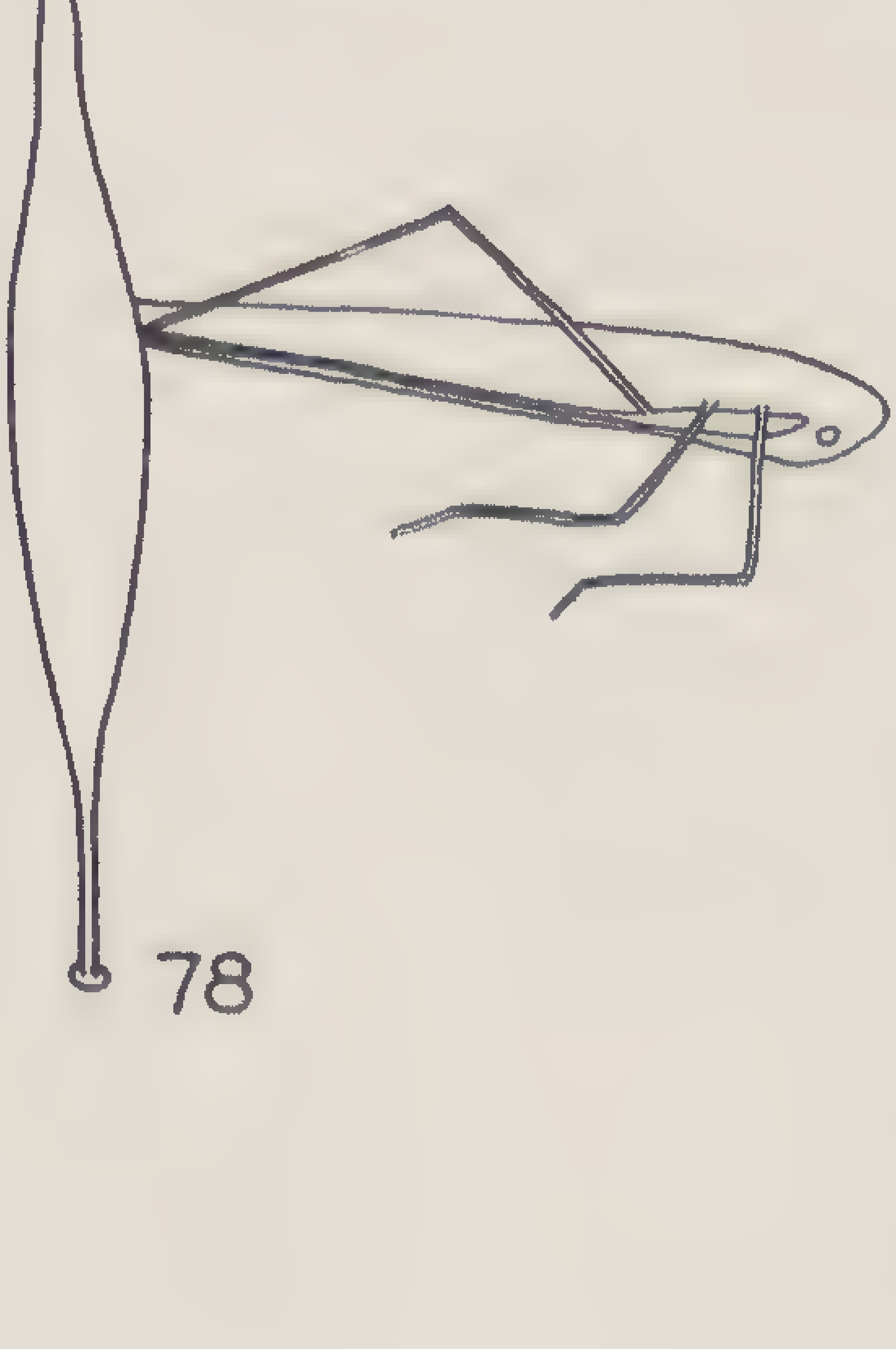
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PLATE XIV

DRAWINGS OF FIRST AND SECOND INSTAR NYMPHS

FIG. 79. Dorsal view of first instar nymph with an extremely contracted abdomen.

FIG. 80. Dorsal view of first instar nymph.

FIG. 81. Ventral view of first instar nymph.

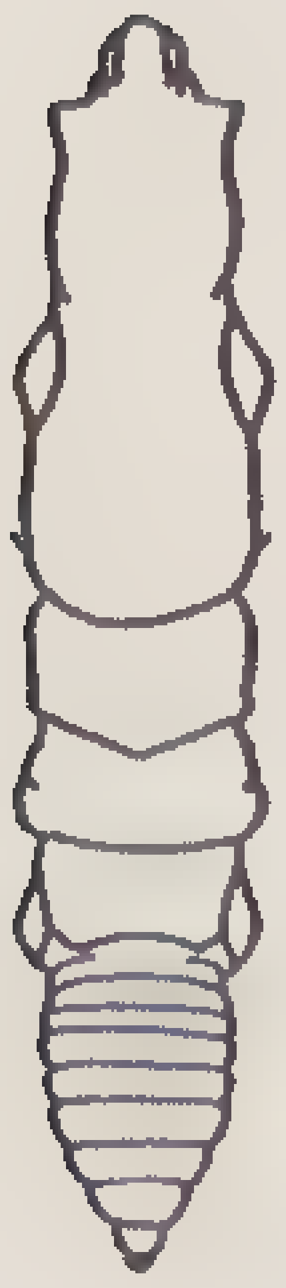
FIG. 82. Lateral view of first instar nymph.

FIG. 83. Ventral view of second instar nymph.

FIG. 84. Dorsal view of second instar nymph.

FIG. 85. Lateral view of second instar nymph.

PLATE XIV



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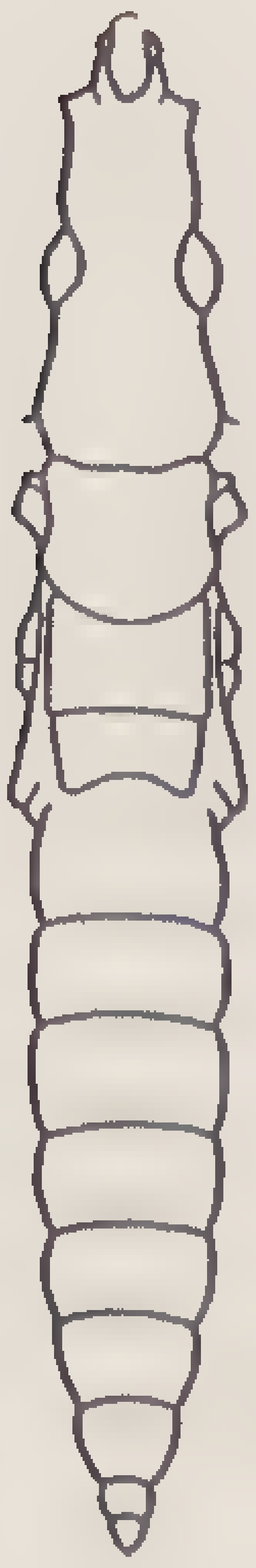

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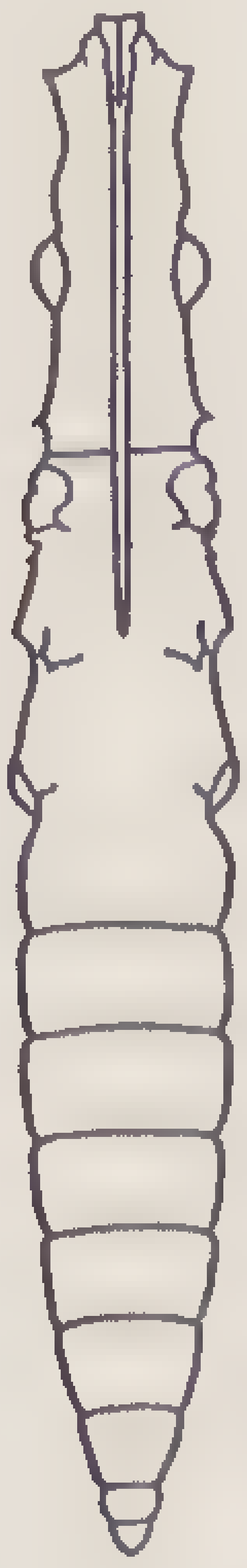

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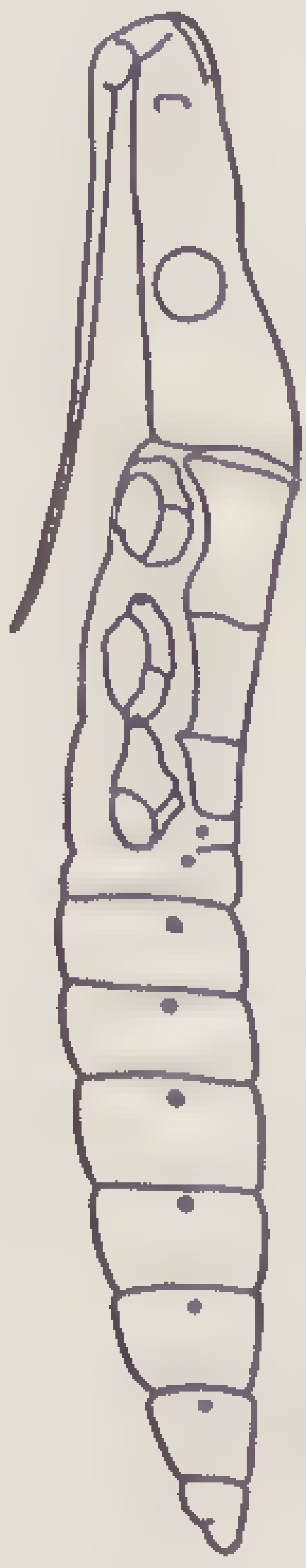

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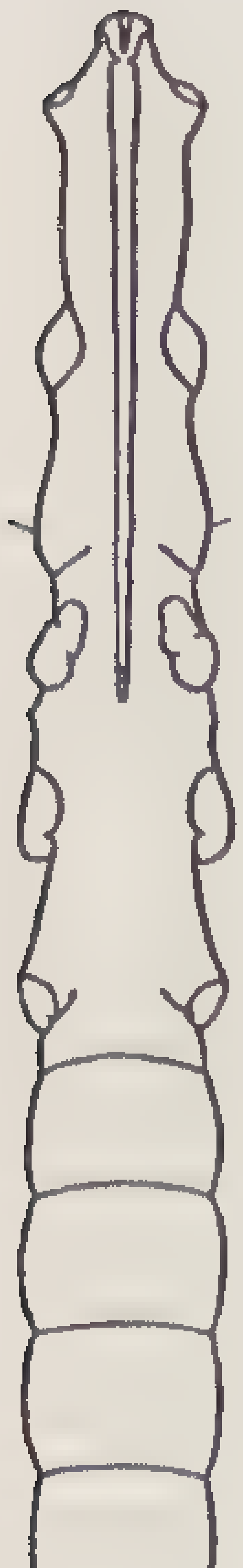

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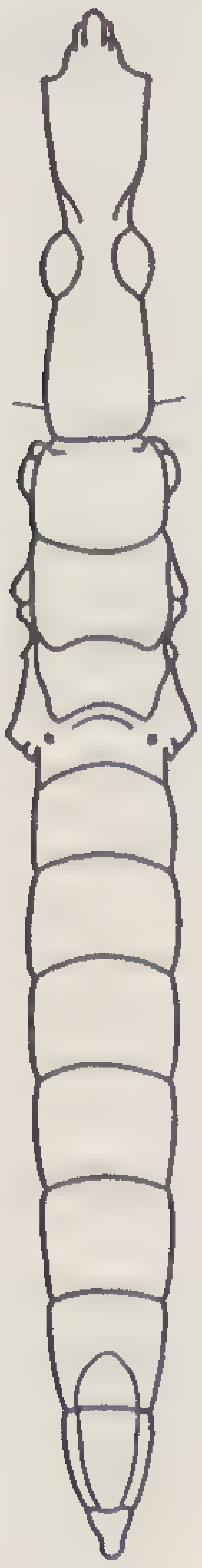

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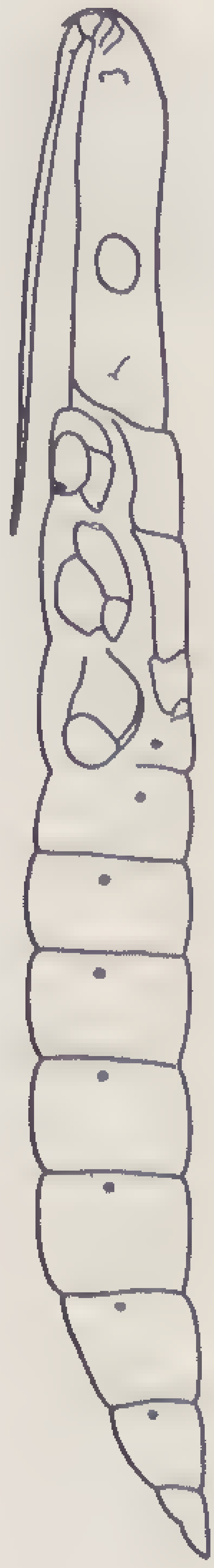

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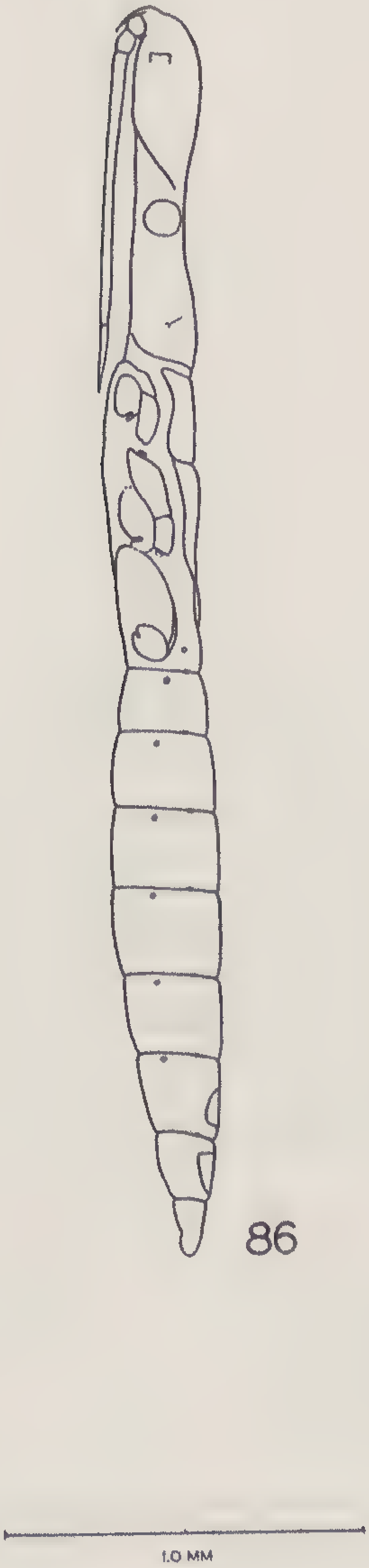
PLATE XV

DRAWINGS OF THIRD INSTAR NYMPHS

FIG. 86. Lateral view.
FIG. 87. Ventral view.
FIG. 88. Dorsal view.

PLATE XV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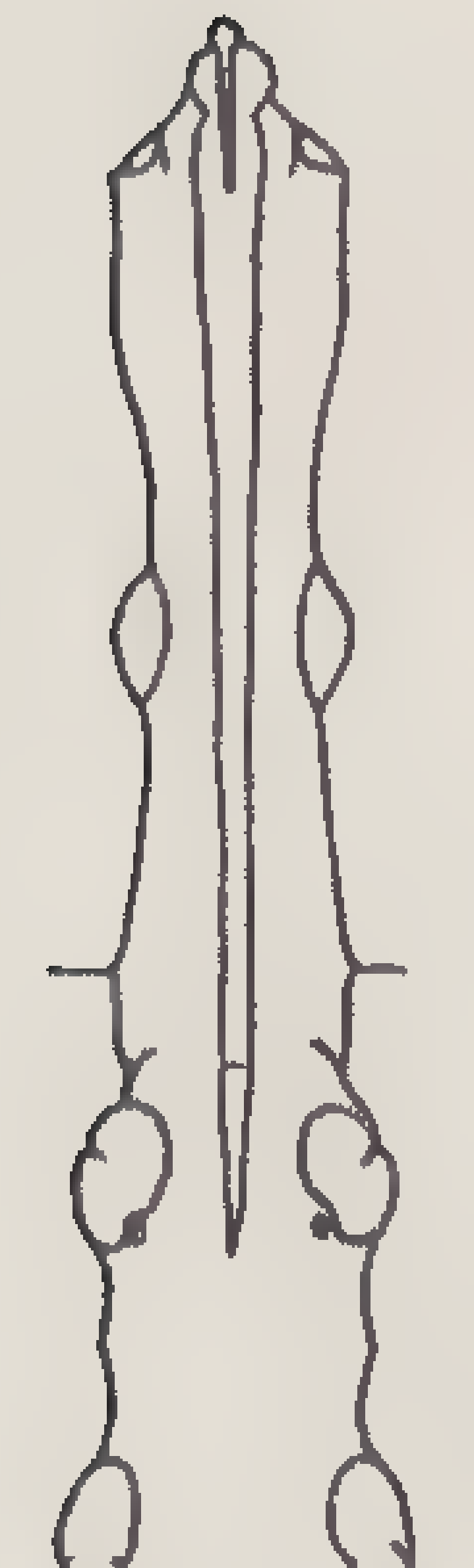
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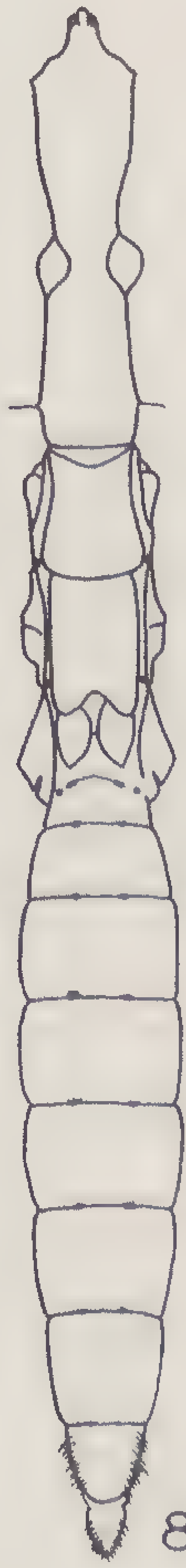
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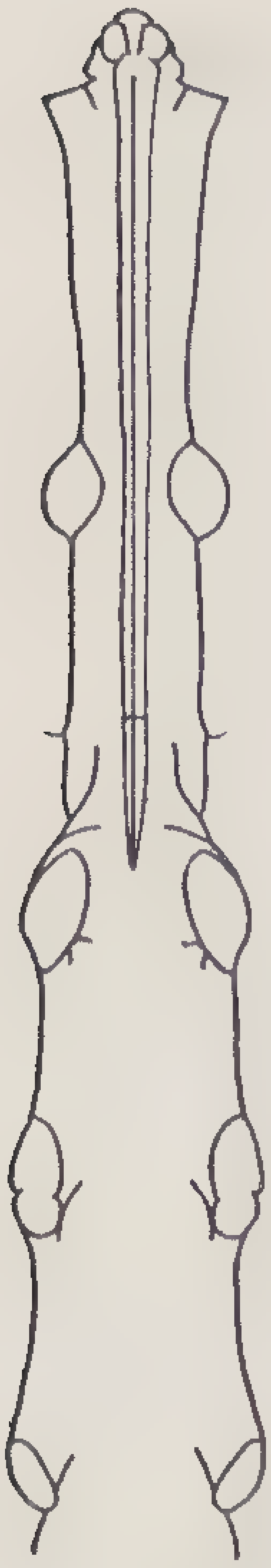
PLATE XVI

DRAWINGS OF FOURTH INSTAR NYMPHS

FIG. 89. Ventral view of head and thorax of apterous form.
FIG. 90. Lateral view of head and thorax of apterous form.
FIG. 91. Dorsal view of head and thorax of apterous form.
FIG. 92. Dorsal view of terminal segments of the male.
FIG. 93. Lateral view of terminal segments of the male.
FIG. 94. Ventral view of terminal segments of the male.
FIG. 95. Dorsal view of terminal segments of the female.
FIG. 96. Lateral view of terminal segments of the female.
FIG. 97. Ventral view of terminal segments of the female.

PLATE XVI



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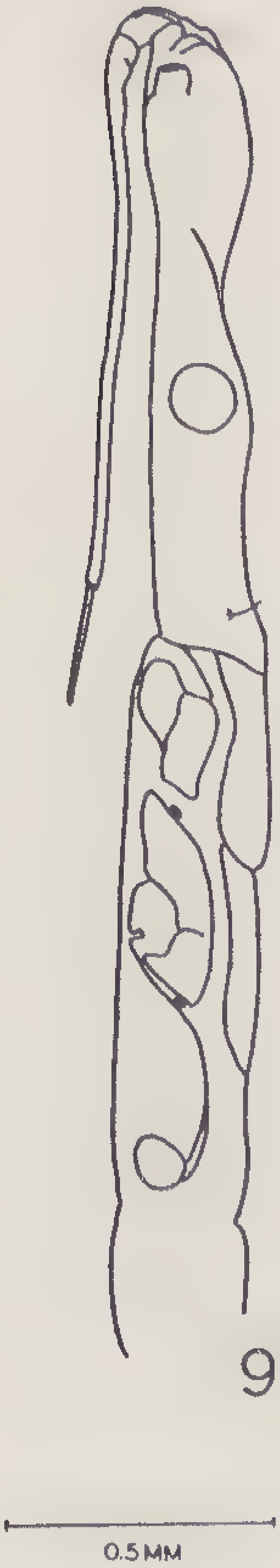

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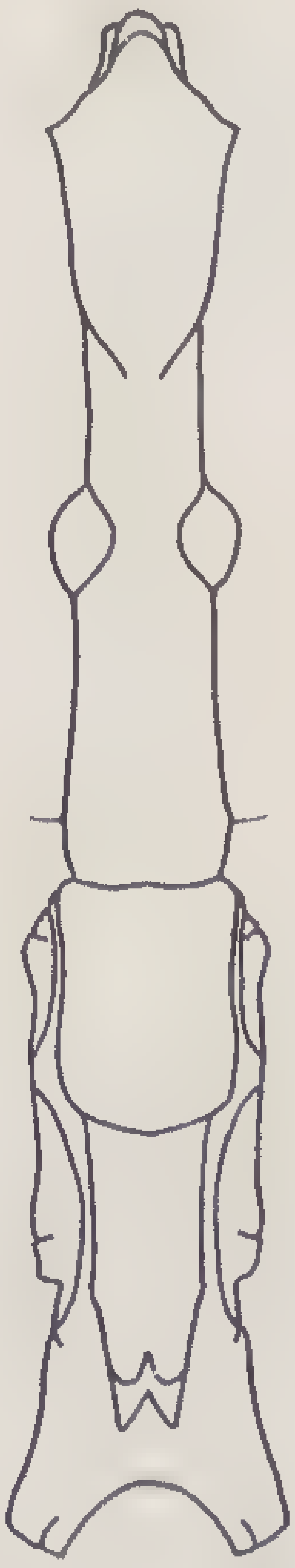

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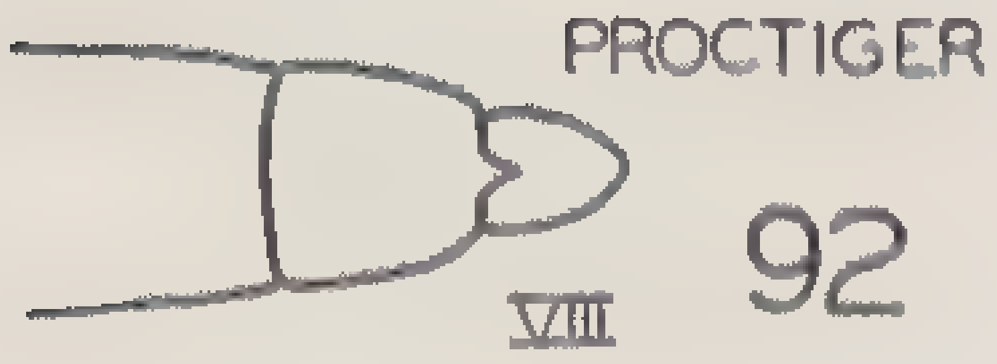

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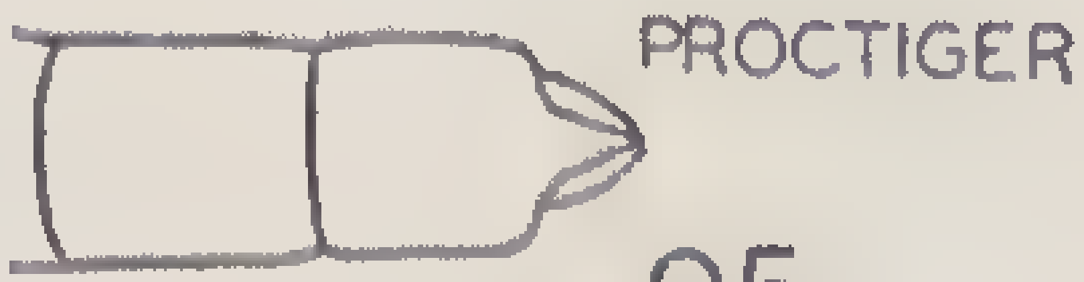

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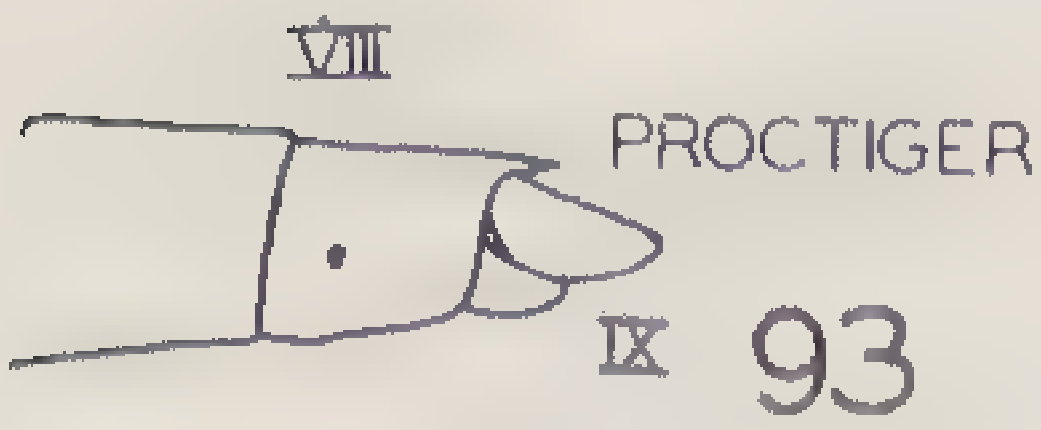

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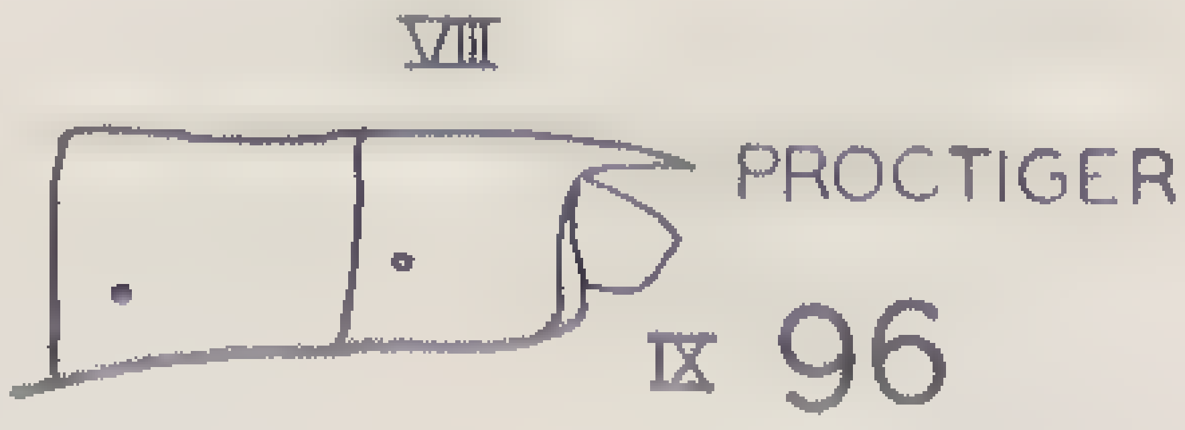

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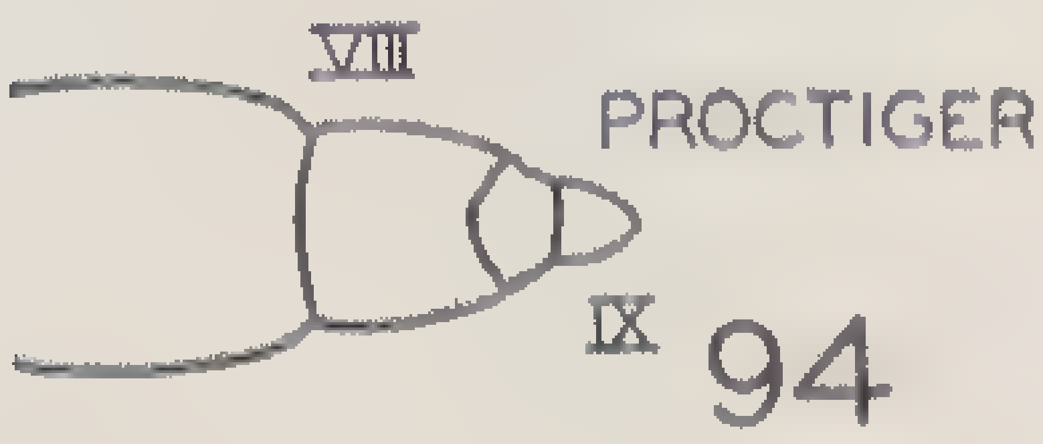

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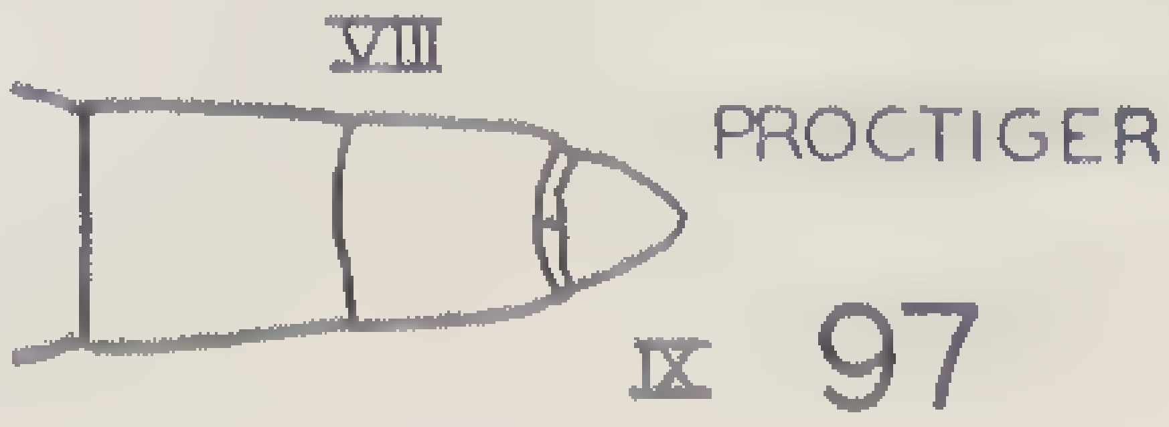

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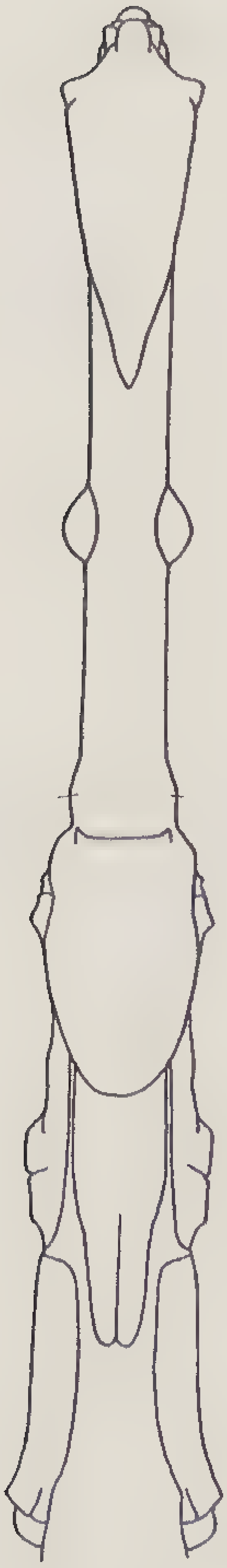
PLATE XVII

DRAWINGS OF FIFTH INSTAR NYMPHS

FIG. 98. Dorsal view of head and thorax of apterous form.
FIG. 99. Lateral view of head and thorax of apterous form.
FIG. 100. Ventral view of head and thorax of apterous form.
FIG. 101. Lateral view of terminal segments of the female.
FIG. 102. Ventral view of terminal segments of the female.
FIG. 103. Dorsal view of terminal segments of the female.
FIG. 104. Lateral view of terminal segments of the male.
FIG. 105. Ventral view of terminal segments of the male.
FIG. 106. Dorsal view of terminal segments of the male.

PLATE XVII



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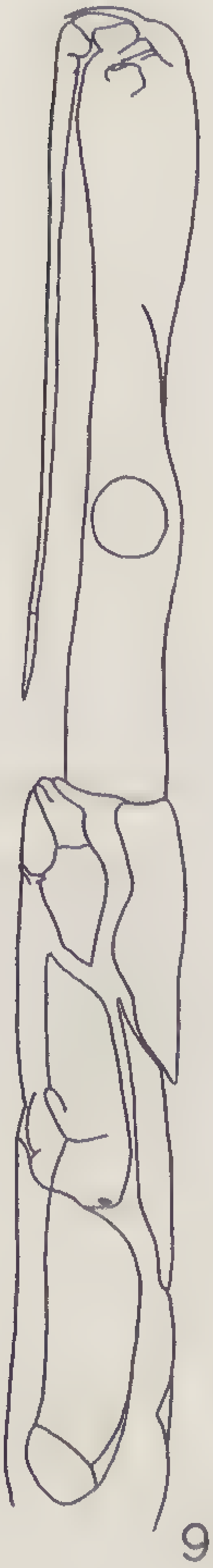

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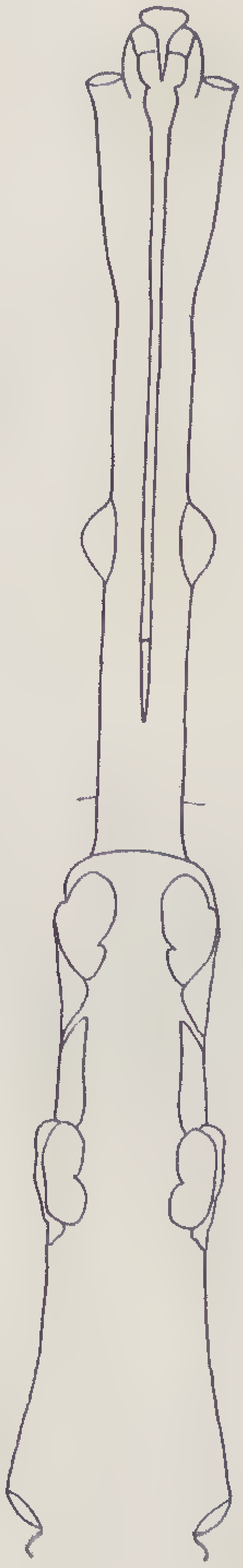

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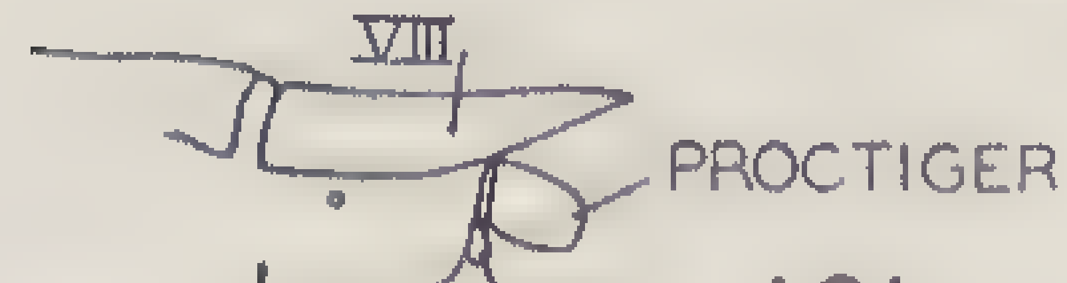

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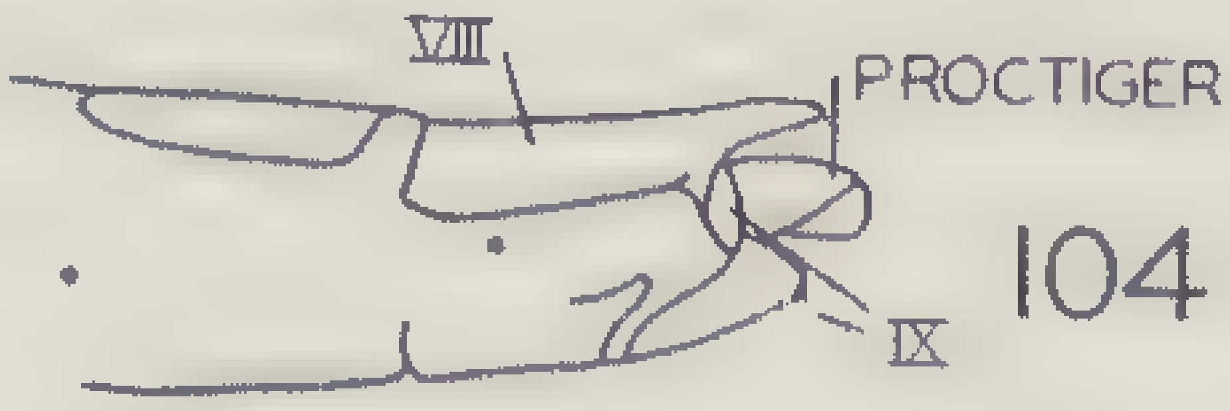

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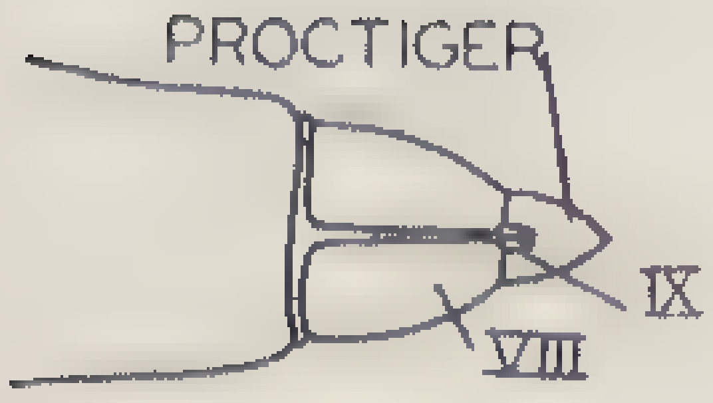

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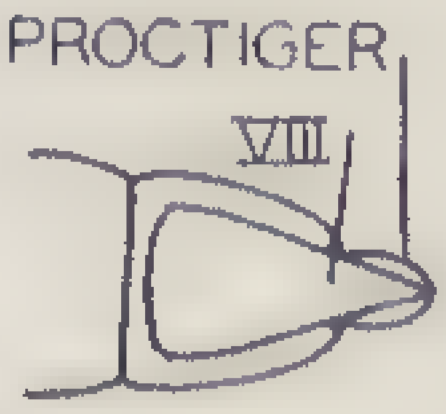

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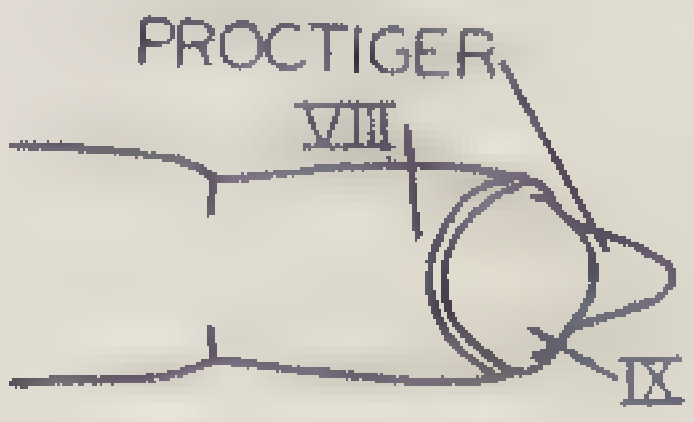

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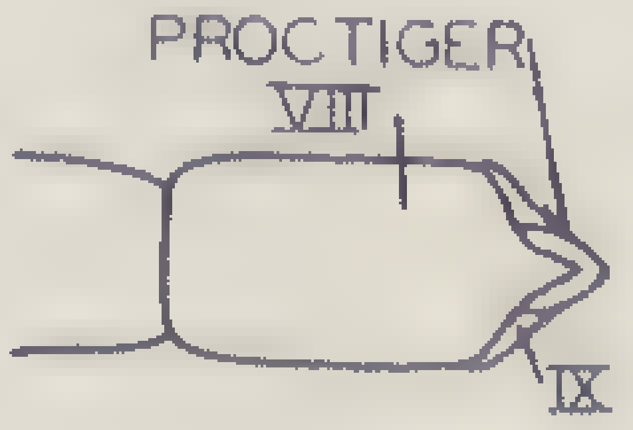

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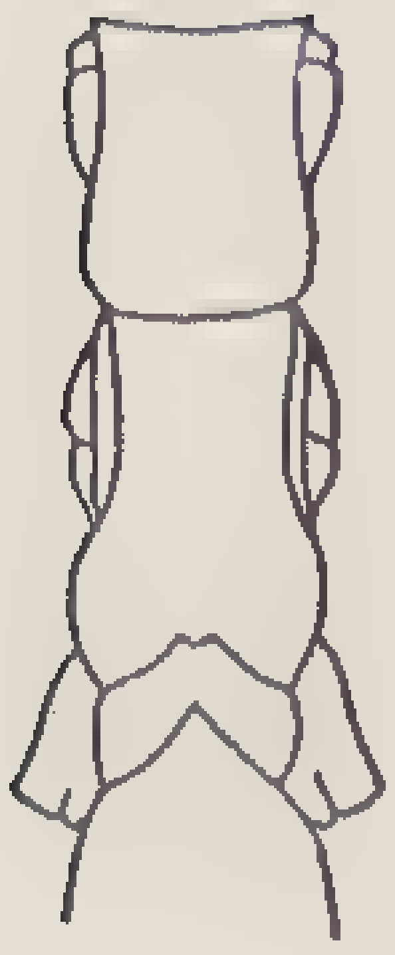
PLATE XVIII

DRAWINGS OF THE THORACES OF NYMPHS OF THE MACROPTEROUS FORM

FIG. 107. Dorsal view of the third instar nymph.
FIG. 108. Lateral view of the third instar nymph.
FIG. 109. Lateral view of the fourth instar nymph.
FIG. 110. Dorsal view of the fourth instar nymph.
FIG. 111. Lateral view of the fifth instar nymph.
FIG. 112. Dorsal view of the fifth instar nymph.

PLATE XVIII



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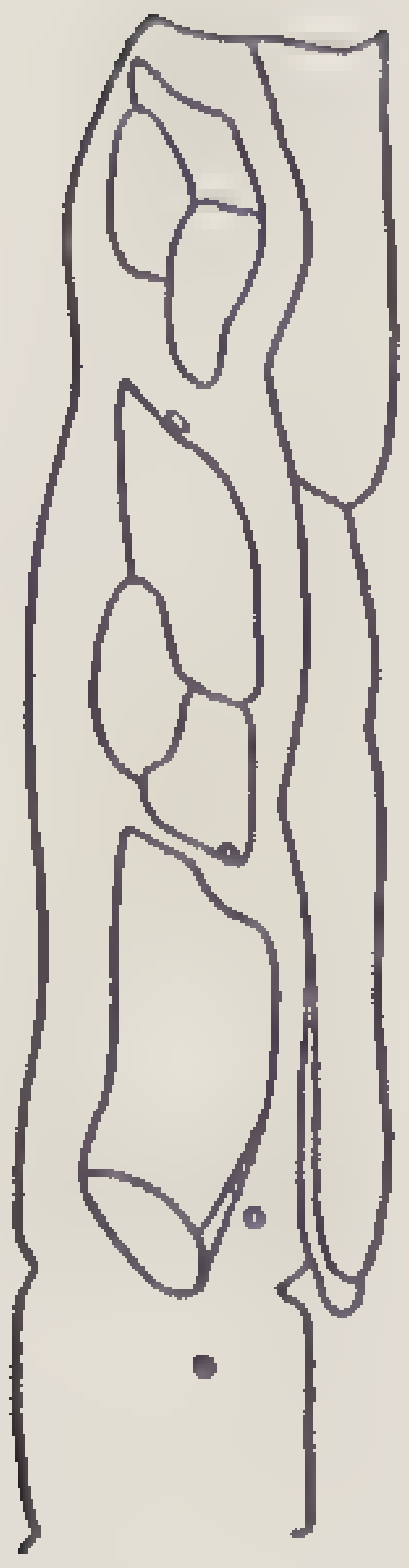

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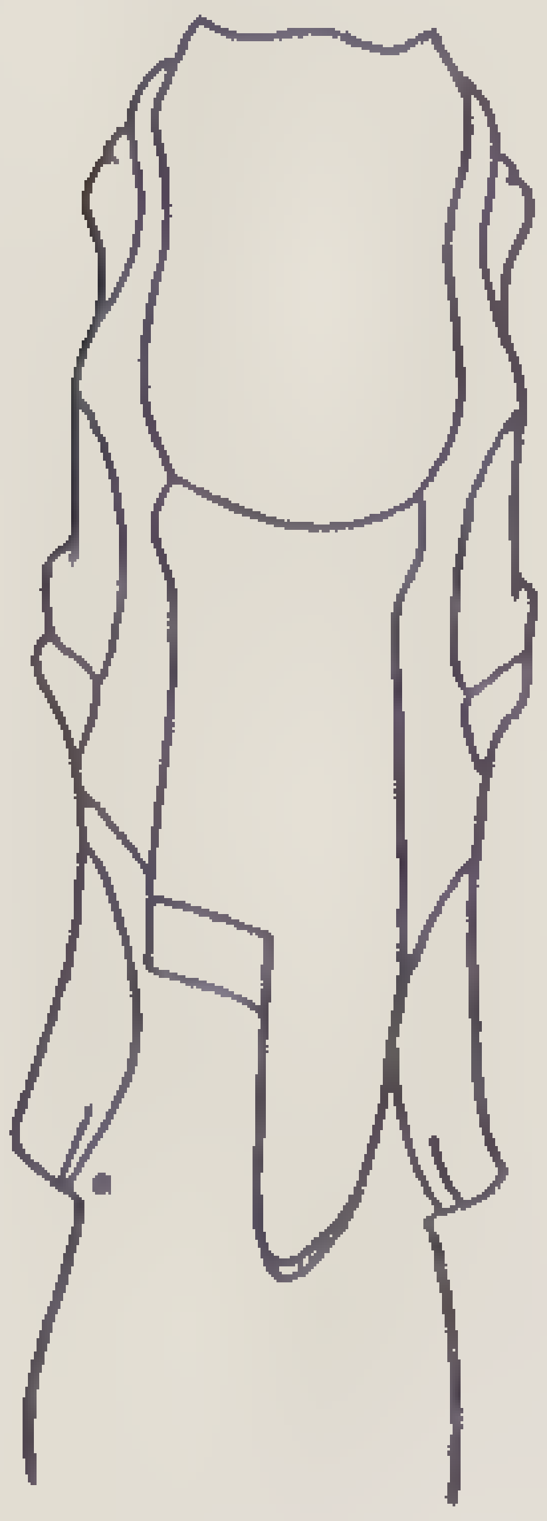

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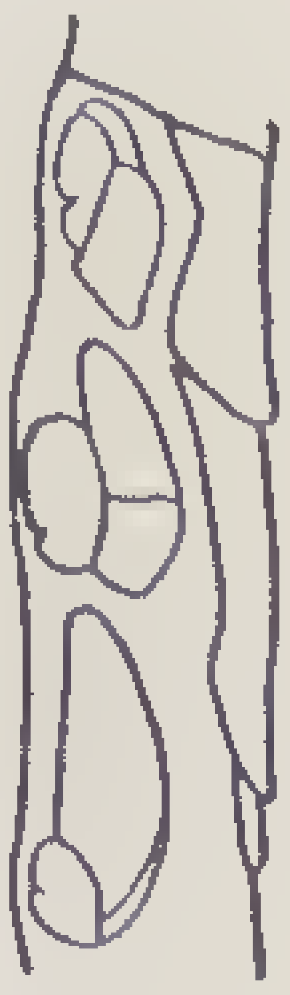

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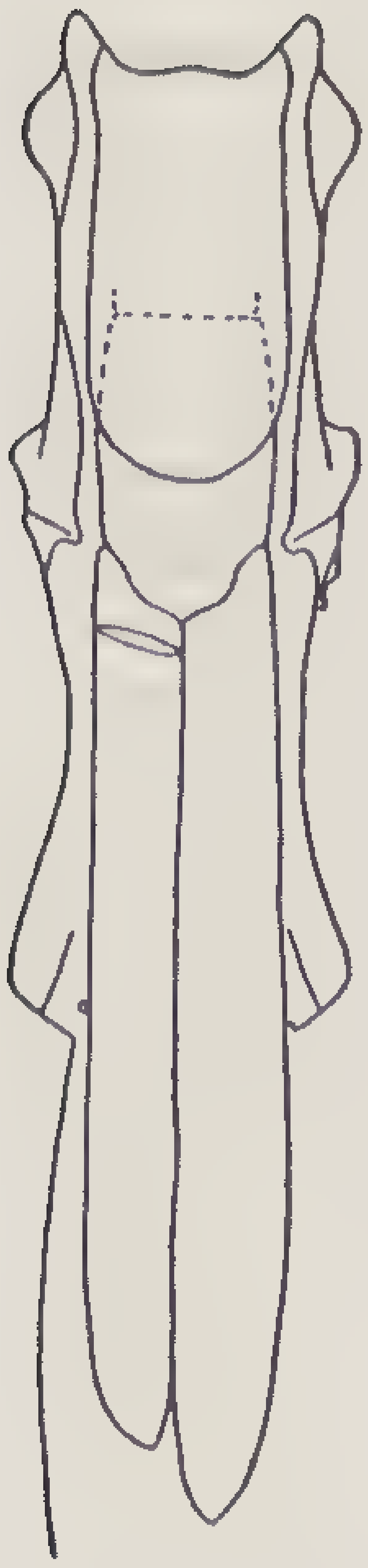

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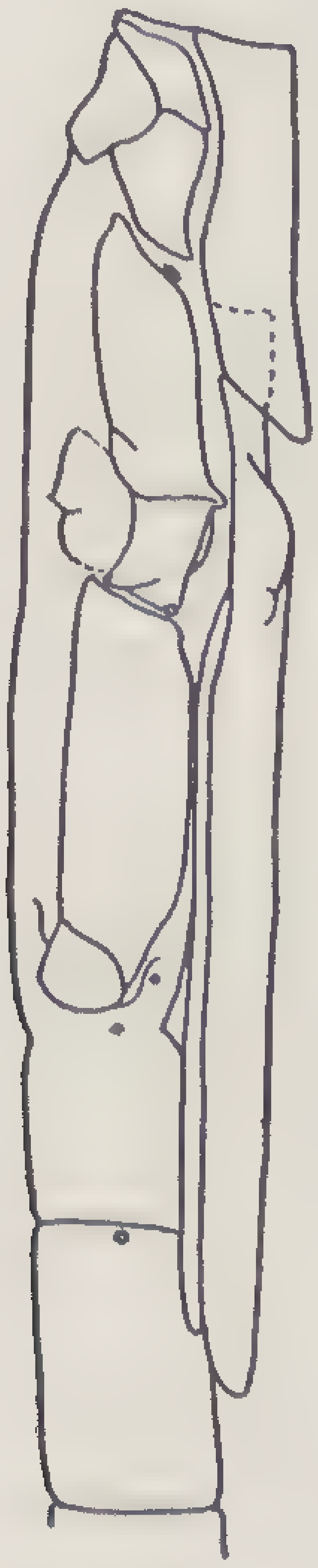

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THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN

VOL. XXXVIII, PT. I] DECEMBER 20, 1956 [No. 10

A Taxonomic Study of the Genus *Rhagovelia* (Hemiptera, Veliidae) of the Western Hemisphere *

BY

JOHN A. BACON
A. B., University of Kansas, 1941

ABSTRACT: This paper includes descriptions of seventy-eight species of the genus Rhagovelia (Hemiptera; Veliidae) from North America, Central America, South America and the Antilles. In addition to the descriptions, a bibliography and the synonymy is given for each species, and detailed data on distribution is presented. Keys to the species groups and to the species within the groups are included.

Twelve new species are named and described: *Rhagovelia acuminata* from Panamá, *Rhagovelia formosa* from Guatemala, Honduras and Mexico, *Rhagovelia gracilis* from Mexico, *Rhagovelia horrida* from Mexico and Guatemala, *Rhagovelia impensa* from Perú, *Rhagovelia merga* from Panamá, *Rhagovelia modesta* from Brazil, *Rhagovelia palea* from Perú and Bolivia, *Rhagovelia scabra* from Costa Rica and Panamá, *Rhagovelia scitula* from Brazil, *Rhagovelia solida* from Costa Rica, *Rhagovelia viriosa* from Perú.

The following specific names become synonyms: *Rhagovelia arctoa* Bueno (= *Rhagovelia obesa* Uhler), *Rhagovelia flavicincta* Bueno (= *Rhagovelia obesa* Uhler), *Rhagovelia gregalis* Drake and Harris (= *Rhagovelia tenuipes* Champion), and *Rhagovelia regalis* Drake and Harris (= *Rhagovelia tenuipes* Champion). The following varietal names become synonyms: *Rhagovelia distincta arizonensis* Gould (= *Rhagovelia distincta* Champion), *Rhagovelia distincta cadyi* Gould (= *Rhagovelia distincta* Champion), *Rhagovelia distincta harmonia* Gould (= *Rhagovelia distincta* Champion), *Rhagovelia distincta modesta* Gould (= *Rhagovelia distincta* Champion), *Rhagovelia distincta proxima* Gould (= *Rhagovelia distincta* Champion), *Rhagovelia distincta valentina* Gould (= *Rhagovelia distincta* Champion), *Rhagovelia sinuata calcaris* Drake and Harris (= *Rhagovelia robusta* Gould), and *Rhagovelia collaris pulchra* Gould (= *Rhagovelia collaris* (Burmeister)). One subspecies *Rhagovelia collaris planipes* Gould has been raised to species level as *Rhagovelia*

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* Submitted to the Department of Entomology and the Faculty of the Graduate School of the University of Kansas in partial fulfillment of the requirements for the degree of Doctor of Philosophy. Contribution No. 927 of the Department of Entomology, University of Kansas.

planipes Gould. One species *Rhagovelia williamsi* Gould, has been re-established as a valid species, removing it from the synonomy of *Rhagovelia amazonensis* Gould.

Brief notes are presented on the biology of *Rhagovelia rivale* Bueno. The history of the family is presented and generic concepts are discussed.

Nine species groups are established and their phylogenetic arrangement within the genus is discussed. The probable phylogenetic arrangement of these groups of species begins with the *angustipes* group. Two paths of development are followed from this beginning. The first includes the *abrupta* group, the *elegans* group, and the *crassipes* group. The second includes the *collaris* group, the *obesa* group, the *ainsliei* group, the *spinigera* group, and the *hirtipes* group.

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INTRODUCTION

The genus *Rhagovelia* Mayr (Hemiptera, Veliidae) was suggested by Professor Herbert B. Hungerford as worthy of taxonomic study. No correlation on a generic level had been made between species which were described after the last generic revision by Doctor George E. Gould in 1931, and those which were described previously. A large number of specimens had been added to the Francis Huntington Snow Entomological Collections in the last two decades giving much additional material for study. At the time of the revision of the genus by Gould in 1931, the entire collection of *Rhagovelia* in the Francis Huntington Snow Entomological Collections, University of Kansas, numbered approximately 5000 specimens, whereas at this writing the author has had approximately twenty thousand specimens available. Most of the additional material was undetermined when the study was begun.

Available keys to the species of the genus *Rhagovelia* have proven unserviceable to the average entomologist. Doctors Carl J. Drake and Halbert M. Harris published descriptions of twenty-eight species and one subspecies subsequent to Gould's 1931 paper. The claspers of the male genitalia, which are of great taxonomic value, were not figured for any of these species, nor was a key incorporating these new species presented. Descriptions by earlier workers were based mostly on color.

The present account provides unified descriptions of all the previously known species represented in the Francis Huntington Snow Entomological Collections, University of Kansas, as well as of the new species which have been found in the course of this work. Workable keys, based on clear-cut structural characteristics wherever possible, and divided into groups of related species of the genus *Rhagovelia* of the Western Hemisphere, are included.

The work of O. Lundblad published in 1933 in Stockholm, Sweden, entitled "Die altweltlechen Arten der Veliidengattungen Rhagovelia und Tetraripis" will serve as an aid for determination of specimens from the Eastern Hemisphere.

Two species, *Rhagovelia trailii* (White) and *Rhagovelia bakeri* Bergroth, are not adequately represented by type material; the original descriptions are not detailed enough to permit their being included in the groups of species or in the keys. Original descriptions of these two species are included at the end of the section on taxonomy.

An addenda follows the section on taxonomy. This addenda includes the recent species published by Dr. C. J. Drake and Dr. R. F. Hussey after 1953. These species were published after the body of the paper was written and thus, in most cases, could not be worked into the body of the paper.

ACKNOWLEDGMENTS

The writer is grateful to each of the following persons: Professor H. B. Hungerford suggested and directed this study and gave valuable advice and criticism. Professor Raymond H. Beamer, in charge of the Francis Huntington Snow Entomological Collections, has given valuable advice and furnished a majority of the specimens studied; many of these specimens were collected by biological survey trips under his direction. Professor E. Raymond Hall has given valuable advice on the preparation of the manuscript. Professor Kathleen C. Doering has given advice on morphological problems. Professor Charles D. Michener has given valuable suggestions regarding intraspecific variation, phylogeny, and general procedure. Dr. Edward A. Chapin of the United States National Museum has permitted the study of the *Rhagovelia* in the collection under his charge. The collection of the late Mr. J. R. de la Torre-Bueno, which contains many specimens valuable in the determination of the previously named species, as well as many type specimens, has been made available and is now in the Francis Huntington Snow Entomological Collections. Dr. W. E. China of the British Museum compared specimens with the types of the species described by Champion. Professor H. M. Harris of Iowa State College has loaned specimens from the collection under his charge.

BIOLOGY OF THE RHAGOVELIA

Individuals of the genus *Rhagovelia* are both small and timid, making it difficult for accurate observations to be carried on under natural conditions. Attempts to observe them in nature rarely are satisfactory. Since *Rhagovelia* is small, an observer must approach closely to see what is going on, and when an attempt is made to get within several inches of individuals of the genus they dart away rapidly just out of range, where they again take up their stations, darting and drifting with the current.

When confined in an aquarium these bugs at once begin frantic efforts to escape, pressing their heads against the glass sides of the aquarium and rowing frantically with their long, strong middle legs. When these efforts to escape fail they take to diving, and swim about under the surface of the water. They swim readily under water and carry down with them a supply of air trapped in the waterproof pile which covers the body. However, they soon tire, and die without trying to regain their position on the surface of the water.

Various attempts, all in vain, have been made by the author to rear *Rhagovelia.* Tanks with running water, and tanks with currents set up by jets of compressed air, did not meet the needs. Attempts to rear specimens on damp sphagnum or on clear water have repeatedly failed; two days was the longest time of survival obtained with either method. With damp filter paper in the bottom of finger-bowls, both adults and nymphs have been kept alive for four and five days. This filter paper must be kept damp or the bugs will perish in a few hours.

Torre-Bueno (1907) has published the most thorough account of the biology of the *Rhagovelia* based on *R. obesa* Uhler. Bueno's observations, amplified by those of the writer on *R. rivale* Bueno, may be summarized as follows:

Habitat

Rhagovelia inhabits principally the swifter streams and rivers. Two species, *Rhagovelia plumbea* Uhler and *Rhagovelia salina* (Champion) are salt- and brackish-water inhabitants, living in the bays and coves along the shores. Most of the species live on fresh water, and prefer swift running streams, one common name of these bugs being "riffle bugs." Doctor Raymond H. Beamer, however, captured a pair of *Rhagovelia distincta* Champion in Arizona on the surface of the water in a horse-tank forty miles from the nearest running water (oral information). In general Rhagovelia congregates in schools on the surface of the water near riffles and rapids.

Activity

Riffle bugs are strong striders on the surface and can maintain their position for some time against a rapid current. Appearing to tire of striving against the current they drift to quieter water where they row slowly near the bank. In nature I have never seen one on the bank or shore, nor swimming under water. The nymphs congregate close to the banks in sheltered areas where they dart about rapidly. In slow flowing water they are most often seen gliding slowly against the current a few inches from the bank. In riffles and rapids they are most often found in the middle of the stream rowing strongly against the current and resting for only a few seconds before again gaining their positions. These insects seem to be gregarious as most often many are congregated in a few pools or riffles while long stretches of the stream will be uninhabited.

Rhagovelia glides by means of a vigorous rowing action of the middle pair of legs while the body is supported by the two other pairs of legs. Observations have been made on the swimming motions of *Rhagovelia* by Champion (1901), Torre-Bueno (1907), and Coker, Millsap and Rice (1936). *Rhagovelia* is clumsy on land, often attempting to row with the middle pair of legs. Individuals are able to walk on a dry surface if not frightened, but are slow and hesitant in comparison with their behavior on the water. On the surface of the water they are vigorous and adept, darting so rapidly that the eye can hardly follow them. Their skill in "swimming" is due to the peculiar construction of the last tarsal segment of the intermediate legs. That segment is cleft for three fourths of its length, and there is a series of long ciliated hairs arising from a common stem in this cleft. This series of hairs, the swimming tuft, can be folded within the cleft of the tarsus or extended fanwise from the cleft. When in use, the entire length of the tarsus is in contact with the water and the slit is vertical to the surface. When in this position the spread tuft of hairs projects beneath into the water and is a powerful auxiliary in swimming. When the insect is swimming under water the tuft of hair is expanded and is of great assistance. The bug glides on the tarsal segments of its anterior and posterior legs which have hairs to aid in supporting the insect when it is resting on the surface film. In captivity the bug often glides with its venter resting on the surface of the water, but in this position it does not move swiftly.

Much time is spent in cleaning the legs and special care is used in the cleaning of the intermediate legs. The intermediate leg is vigorously scrubbed between the anterior femur and the anterior tibia. Another cleaning action, seen frequently, also involves the middle leg. In this action the middle leg is scraped against the ventral surface of the posterior femur. The posterior femur in most species of *Rhagovelia* is set with long, sharply pointed spines, and the intermediate leg is drawn repeatedly back and forth over these spines, which act as a comb to clean and straighten the swimming plume of the intermediate tarsus.

Food

It is difficult to determine exactly the food used by *Rhagovelia*. In common with other members of the family Veliidae, riffle bugs are predaceous, living on various microcrustaceans and small insects trapped in the surface film. Numerous attacks on small lepidopterous larvae, which were being carried by the current, have been observed but in no instance did the *Rhagovelia* remain with the larvae for more than a few seconds. Nymphs of *Rhagovelia* probably feed on microcrustaceans which are picked up from the surface film, and on other types of animal matter. Second and third instar nymphs have been observed to feed on mosquito larvae which were stranded but still alive, as well as on abdomens which had been removed from grasshoppers. When feeding on insects as hard-bodied as grasshoppers the bugs probe with their beaks until unsclerotized areas are located and then settle down to feed for ten to fifteen minutes. As feeding progresses the abdomen of the feeding bug becomes distended with the material taken in. One observation of a third instar nymph of *R. rivale* feeding on a live stranded fourth-instar larva of a *Culex* mosquito showed the feeding process to last approximately ten minutes. The nymphal bug was confined in a finger-bowl with damp filter paper on the bottom. A fourth instar mosquito larva was placed on this damp filter paper. In the course of its restless wanderings the *Rhagovelia* nymph soon walked over the mosquito larva. Seemingly recognizing its danger, the mosquito larva began thrashing about vigorously; nevertheless the nymphal bug inserted its beak between the third and fourth abdominal segments and proceeded to suck the contents from the body of the mosquito larva.

Mating

Torre-Bueno has described the mating behavior in some detail for *R. obesa;* the author has observed copulation for *R. rivale*, and the details are the same for the two species. In copulation the male is above. The male sets his hind femora at right angles to his body, bending the tibiae under, and by means of them holds the female's second and third pairs of legs straight and close to her body. Once he is firmly on her, he releases this hold, but maintains his position by the anterior legs, which clasp the female over the prothorax. He is not connected with the female continuously while on her back. The actual connection is only for a few seconds' duration; each time that it occurs the genital segments of the male are bent downward and under to effect connection. After the act the male lies quiescent upon the back of the female. As long as the male is on her the female does all the skating.

Oviposition

Little is known about the oviposition of *Rhagovelia.* Eggs are probably glued at the waterline on stones in the streams, or to the upper surface of floating leaves of water plants. Since there is great difficulty in keeping *Rhagovelia* alive in aquaria, it has not been possible to determine the preference of locality for oviposition. Live adults, which were frequently copulating, were kept under close observation, but no oviposition was observed. The adults were confined two days before the last female died. Eight days after the death of the last adult female first instar nymphs were observed in the aquarium. The period of incubation would thus fall somewhere between eight and ten days.

Immature Stages

The nymphs of *Rhagovelia* are flattened and oval, with the pronotum sutured off from the mesonotum in all stadia. There are five nymphal stadia, during which progressive development takes place. The wing pads of those individuals which will develope into winged adults first appear in the fourth instar and are well developed in the fifth instar. The length of time required for each instar has not been reported, since no means has been found for keeping them alive in captivity for more than five days. Several nymphs were observed in the process of molting. First the old nymphal skin splits along the mid-line of the back from between the eyes to approximately the middle of the abdomen. Next the thorax is freed and it is followed by the head, antennae, front legs, hind legs and finally the long intermediate legs. Several nymphs have been kept in captivity until time to shed the skin, but each was unable to survive this ordeal, either drowning if kept on water, or dying if kept on damp filter paper. How the skin is shed in nature is not known.

Hibernation

Hibernation probably is in the adult stage. The collections made earliest in the spring included only adult males and females. Later in the season only nymphal forms are to be found, and by midsummer mixed adult-nymph collections can be made. Where hibernation takes place is unknown; the litter at the edge of the stream probably is the place.

Collecting Techniques

Rhagovelia is comparatively easy to collect, but requires a quick hand and proper equipment. Equipment needed consists of a water net, or, more easily handled, a six-inch tea strainer which will offer less resistance to the current than does a net. The strainer can be tied on the end of a stick or pole that can be picked up at the scene; also several jars or wide-mouthed bottles one-fourth full of damp sphagnum moss or damp leaves are a necessity if the specimens are to be brought to the laboratory alive. If the specimens are to be killed a wide-mouthed cyanide killing bottle may be used, or a little tobacco smoke can be blown into the jars containing the damp sphagnum, which are then sealed. In a short time all the specimens will be dead and can be transferred to vials of seventy percent alcohol, or into pillboxes lined with several layers of cellucotton. Often *Rhagovelia* congregates in such numbers that a single dip with the net will capture a dozen individuals. Usually, however, only one individual can be captured at a time. To bring specimens into the laboratory alive it is only necessary to cover the top of the jars containing damp sphagnum with cheesecloth or to punch several holes in the metal screw top cover with which such jars are usually equipped. Treated in such a manner, specimens will stay alive for at least one day. If placed in bottles containing water the specimens will drown before they can be brought into the laboratory.

The sexes skate together in the riffles and along the banks and both sexes are generally represented in equal proportions in any random collection.

TAXONOMIC HISTORY AND GENERIC CONCEPTS

The genus *Rhagovelia* was established in 1865 by G. L. Mayr to receive three species which had been described in the genus *Velia* by H. C. C. Burmeister in 1832. Mayr's generic concept included three-segmented tarsi throughout and the third tarsal segment of the intermediate leg cleft for three fourths of its length. In 1871 P. R. Uhler described the species *Rhagovelia obesa* from the United States, and, in 1872, *Rhagovelia plumbea* from the British West Indies. The minute basal tarsal segments of the anterior tarsus on some species were difficult to observe. This led to the establishment of two new genera based on the reduced number of segments in the anterior tarsus. In 1879 F. B. White erected the genus *Neovelia* to receive his *trailii*, and 1898 G. H. Carpenter erected the genus *Trochopus* to receive the species *marinus*. In 1898 G. C. Champion described the species *salinus* and placed it in the genus *Trochopus* thus making two species in that genus. Also in 1898 G. Breddin described a second species, *whitei*, in the genus *Neovelia*.

In 1901-02, G. W. Kirkaldy published a series of papers in which he stated that he had examined material from the type locality of *Trochopus marinus* Carpenter and after careful study of the anterior tarsus had reached the conclusion that Carpenter's *Trochopus marinus* was identical with *Rhagovelia plumbea* Uhler, and that the names *Rhagovelia* and *Trochopus* applied to the same genus. In the same series of papers he also placed the genus *Neovelia* White as a synonym of the genus *Rhagovelia.*

Champion's description of nine new *Rhagovelia* in the "Biologia Centrali-Americana," more than doubled the number of known species in the genus. Kirkaldy described two new species in his 1901 paper, and published a check list of the nineteen species known from the Western Hemisphere. Since then several writers have added to our knowledge of the genus. J. R. de la Torre-Bueno, C. J. Drake, H. M. Harris, and George E. Gould, among others, have described many new species since the turn of the century. Gould, in 1931, published keys and descriptions of the then known species, which totaled forty for the Western Hemisphere. After 1931 Drake and Harris continued their work on the genus *Rhagovelia,* adding eighteen new species and one variety between the years 1933 and 1940.

PHYLOGENY

The genus *Rhagovelia* is one of the two most highly specialized genera in the family Veliidae. Both *Rhagovelia* and *Veloidea* have the peculiar construction of the third tarsal segment of the intermediate leg. The genus *Veloidea* has the posterior as well as the intermediate tarsi split and set with a swimming plume. The possession of these modified tarsal segments is a factor which enables the members of these two genera to adapt themselves to their specialized environment.

Of the groups of species within the genus as set up in this paper, the *angustipes* group is considered to be the most primitive because of the sutured off pronotum (which agrees with the condition found in all *Rhagovelia* nymphs) and the broad, evenly tapering dorsum of the abdomen of the apterous female such as is found in the other members of the family *Veliidae.* Two distinct lines of development can be traced from this beginning. In the first line the abdomen of the apterous female remains much as in the primitive condition. This line includes such groups of species as the *abrupta* group, the *elegans* group, and the *crassipes* group. The second line is characterized by the apterous female having the dorsum of the abdomen narrow after the first three segments. This second line of development includes the *collaris* group, the *spinigera* group, the *obesa group,* the *ainsliei* group, and the *hirtipes* group.

The spinelike termination of the last genital segment which occurs on several species was found to have arisen independently in at least three groups. The shape of the claspers of the male genitalia generally agree as to basic type within any one group. With this fact in mind, an examination of the species which have the spinelike termination of the last genital segment shows, at once, that several different types of claspers are involved. *Rhagovelia uncinata* Champion is closely related to the other members of the *elegans* group, yet possesses the mucronate genital segment. *R. acuminata* sp. nov. is clearly in the *collaris* group, yet *R. acuminata* also possesses the mucronate genital segment. *R. ainsliei* Drake and Harris, *R. becki* Drake and Harris, and *R. gracilis* sp. nov. all agree in having a mucronate genital segment, but are closely related to the *obesa* group in the form of the dorsum of the abdomen of the apterous female. In this one case it was thought convenient to include these three species in a group, known as the *ainsliei* group, as they are so well set off from the *obesa* group by the form of the male clasper, as well as by the mucronate genital segment.

DISTRIBUTION

Each description in the taxonomic part of this paper is followed by a section entitled "Data on Distribution." Previous published records for the species and its synonyms are indicated in the first paragraph of the section; the remainder of the section is devoted to listing the specimens examined by the writer in the course of preparation of this paper. It must be borne in mind when inspecting the published records of distribution that the records have not been verified as pertaining to correctly identified species.

The known geographic ranges of most species is extended by the record-stations of occurrence mentioned in this paper; all such records are indicated by an asterisk immediately before the name of the country or state concerned. The countries are listed alphabetically. The states of Mexico and the United States are listed alphabetically under the country to which they pertain, and the locality, date, collector and number of specimens of brachypterous and macropterous forms of each sex are listed. Unless otherwise indicated specimens are in the Francis Huntington Snow Entomological Collection. A parenthetical entry indicates the source of the other specimens from each locality. The type specimens in the

Francis Huntington Snow Entomological Collections, University of Kansas which are mentioned in the "Data on Types" are not relisted in the "Data on Distribution" section.

As far as can be determined, there is no species with a circumpolar distribution in the genus *Rhagovelia.* Several species of the Eastern Hemisphere fit well into groups established in this paper.

Rhagovelia is mainly tropical and semitropical. Mexico, Central America, the islands of the Caribbean, and northern South America contain the major number of species within the genus. One group, the *obesa* group, occurs throughout the United States. The species *R. obesa* Uhler has the most northerly distribution of any *Rhagovelia,* having been taken as far northward as Ontario, Canada.

A study of the *Rhagovelia* collection of the Francis Huntington Snow Entomological Collections, University of Kansas, indicates that winged forms are more frequently taken on the small, temporary brooks and streams, while apterous individuals are mostly found on the larger, more permanent bodies of water. The winged form is unknown in the two salt-water species, *R. salina* (Champion) and *R. plumbea* Uhler. This would indicate that the presence or absence of wings is controlled by the environment. The individuals which live on water which will continue to support them have no need of wings, whereas the individuals living on water which is only temporarily flowing, or that is apt to evaporate, need wings to seek out other water on which to continue their existence.

It is the opinion of the author that the distribution of the species of the genus *Rhagovelia* as recorded in this paper represents merely the areas of collection rather than the range of the species. It is felt that many more species of this genus will be discovered and the present known range of many existing species will be increased when a more complete coverage of many areas in Central and South America is undertaken.

IDENTIFICATION TECHNIQUES

Early workers depended almost entirely on color and color patterns for the differentiation of species in the genus *Rhagovelia.* Structural characteristics were ignored or unobserved while a slight variation in color was considered sufficient basis for establishing a new species. This led to much confusion since, in most cases, the color descriptions applied in full only to the specimen from which they were written. In this paper a description of the color is given for each species. This color description is intended to serve only as guide to the most common color pattern and must be flexibly interpreted.

Descriptions and keys in the present paper are based on the apterous forms as this seems to be the normal condition for the genus; more than one third of the species are known only from the apterous forms. However, most winged forms can be determined by noting group characteristics which apply to the winged forms and by the shape of the male clasper which will, in most species, clearly show group relationships if not specific identity. The apterous male usually shows the best specific characteristics, while the apterous female shows the group relationships most clearly.

The principal structural characteristics which have proven valuable are the proportions of the segments of the antennae (principally in the *angustipes* group), and the comparative length to width of the pronotum of the apterous forms. The armature of the anterior and posterior trochanter, the pattern of armature of the posterior femur, the clasper of the male genitalia, and the form of the venter of the last abdominal segment of the male provide other useful characters. A character which has not been used previously, and which is apparently constant for a given species, is the presence or absence of certain minute conical black setae or spicules (Pl. I, fig. 4) on parts of the venter of the body. These minute conical setae are arranged in the same manner in apterous and winged forms of both male and female specimens except that those of the females tend to be slightly reduced in many species.

Characteristics which have been found to be variable in many species include the incrassate condition of the posterior femur of the male, the proportions of the last two tarsal segments of the intermediate leg, and in some species the armature of the posterior femur. All such variation noted is mentioned in the description of the species involved.

The measurements given for each species were made with a combination of 9X oculars with a squared reticle, and 6.8X objective lenses on the binocular microscope. At this magnification each ten units of the reticle equals .15 mm. Conversion to millimeters has been made only for length and width of the entire insect; all other measurements are in units of the reticle. In the measurement of the segments of the antennae the minute "node" at the base of the third segment is considered to be a part of that segment. In measuring the length and width of the pronotum as well as segments of the legs care must be taken to have the body of the insect or the part being measured as nearly horizontal as possible. Limited variations in the proportions given in the descriptions of the species may be expected. Whenever proportions are used as key characteristics it is intended that the couplets of the keys be strictly interpreted, since they are phrased in such a manner as to be mutually exclusive after considering the maximum variation to be expected. The width of the insect is the greatest width of the dorsum; the length of the pronotum, mesonotum and metanotum is measured on the mid-line. In measuring the projecting spine on the pronotum of the winged forms the projection beneath the spine, which marks the apex of the pronotum, is used as a base. Some variation must be expected from that given for the armature of the posterior femur. In general the descriptions are stated in such a way as to allow for known variation.

In order to examine the male genitalia it is necessary to remove the genital capsule. After relaxing the male specimen with a drop of five percent alcohol it is easy to remove the genital capsule with a pair of fine-pointed forceps. The capsule is boiled in ten percent potassium hydroxide for approximately five minutes and is then neutralized in a one percent solution of hydrochloric acid. The capsule is then placed under glycerin on a well-slide. Dissecting needles made from "minutennadeln" can be used to tease the claspers from their attachment within the capsule. The clasper is examined under the dissecting microscope with the blade pointed toward the observer's right. Extreme care must be taken to obtain a flat surface view of the blade of the clasper. This is best accomplished by submerging a fragment of a broken glass cover-slip beneath the glycerin and propping the free end of the clasper on this support. After observation of the clasper, it, along with the genital capsule, may be stored in a tiny glass vial containing a small amount of glycerin. The vial may be pinned through its cork beneath the specimen from which the genital capsule was removed. Permanent slides of the claspers have been found to be highly unsatisfactory as the angle of view cannot be accurately controlled. The "penis appendages" of Gould were not used in the determination of specimens because these appendages are entirely too fragile and too little chitinized to retain their shape after boiling in potassium hydroxide. The aedeagus of the males and the ovipositors of the females are unsatisfactory from the standpoint of specific determination.

Genus RHAGOVELIA Mayr

Logotype *nigricans* Burmeister

1865. *Rhagovelia* Mayr, Vehr. Zool. -bot. Ges. Wien, Bd. 15, p. 445.
1865. *Baecula* Stål, Hemiptera Africana, vol. 3, p. 157.
1879. *Neovelia* White, Jour. Linn. Soc. London, Zool., vol. 14, p. 487.
1898. *Trochopus* Carpenter, Ent. Mo. Mag., vol. 34, p. 78.

Generic characteristics: Minute to medium-sized bugs, oval to fusiform in general shape. Head marked with a median impressed line and several lateral dots. Rostrum extending to mesosternum; three segmented. Antennae long, four segmented, first segment curved and longest; first three segments bearing long, scattered, erect setae. Wings without clavis, corium or embolium. Veins well-developed on basal two thirds of wings, becoming obsolete toward apex. Apterous forms common and with no trace of wings or wing pads. Anterior legs not fitted for grasping. Intermediate legs modified as swimming legs. Third tarsal segment of intermediate leg split for three fourths its length and this split furnished with retractable, feathered hairs arising from a common base. All tarsi three-segmented, the first segment usually much reduced. Third tarsal segment of all legs provided with a pair of claws set in before the apex. Posterior femur generally spinose beneath, especially in the male. Abdominal segments and genitalia bilaterally symmetrical.

KEY TO THE SPECIES GROUPS OF THE GENUS RHAGOVELIA

(Pl. II)

1. Pronotum of apterous forms shorter than length of eye, posterior margin straight or slightly concave . . . . *angustipes* group
   Pronotum of apterous form longer than length of eye, posterior margin convex 2
2.(1) Pronotum of apterous forms much less than three times as long as exposed portion of mesonotum . . . . *abrupta* group
   Pronotum of apterous forms more than, or approximately three times as long as exposed portion of mesonotum, or pronotum covering mesonotum 3
3.(2) Posterior tibia armed at apex with a sickle-shaped spur, *elegans* group
   Posterior tibia with or without a distinct terminal spur which may be slightly bent but never with a sickle-shaped spur at apex 4
4.(3) Dorsum of abdomen of apterous female definitely narrowed abruptly after first three segments 6
   Dorsum of abdomen of apterous female tapering more or less evenly to apex 5

5.(4) Intermediate leg of apterous female with tarsal segment II subequal to tarsal segment III .... *hirtipes* group
Intermediate leg of apterous female with tarsal segment II definitely shorter than tarsal segment III .... *crassipes* group
6.(4) Intermediate femur of female transversely constricted at middle, *spinigera* group
Intermediate femur of female not thus constricted 7
7.(6) Intermediate femur of female flattened beneath on basal one fourth; male usually with anterior tibia greatly dilate and excavate beneath .... *collaris* group
Intermediate femur of female dorso-ventrally flattened from basal one fourth to apical one fourth; male with anterior tibia never greatly dilate and excavate beneath 8
8.(7) Last genital segment terminating in an elongate spinelike process, *ainsliei* group
Last genital segment not as above .... *obesa* group

ANGUSTIPES GROUP

Group characteristics: The *angustipes* group can be characterized as consisting of those species of the genus *Rhagovelia* in which the pronotum of the apterous form is shorter than the length of the eye, with the posterior margin straight or concave. The dorsum of the abdomen of the apterous female tapers rather evenly to the apex. Winged forms are rare; the wings extend well beyond the apex of the genital segments.

The following species comprise this group:

1. *R. angustipes* Uhler
2. *R. bisignata* Bacon
3. *R. callida* Drake and Harris
4. *R. calopa* Drake and Harris
5. *R. deminuta* Bacon
6. *R. evidis* Bacon
7. *R. festae* Kirkaldy
8. *R. fontanalis* Bacon
9. *R. hambletoni* Drake and Harris
10. *R. imitatrix* Bacon
11. *R. janeira* Drake
12. *R. longipes* Gould
13. *R. modesta* sp. nov.
14. *R. novana* Drake *
15. *R. paulana* Drake
16. *R. plana* Drake and Harris
17. *R. plumbea* Uhler
18. *R. rioana* Drake *
19. *R. salina* (Champion)
20. *R. spinosa* Gould
21. *R. tantilla* Drake and Harris
22. *R. tenuipes* Champion
23. *R. velocis* Drake and Harris
24. *R. versuta* Drake and Harris
25. *R. viriosa* sp. nov.

KEY TO SPECIES OF THE ANGUSTIPES GROUP

1. Posterior femur of both sexes unarmed 2
Posterior femur armed at least in male 4
2. (1) Posterior tibia normal in length .... *festae*
Posterior tibia at least one third longer than posterior femur 3
3. (2) Antennal segment II distinctly shorter than III (at least in apterous female) .... *longipes*
Antennal segment II subequal to III .... *imitatrix*

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* See addenda at end of section on taxonomy for the description of this species which was published after the body of this paper was written.

4. (1) Venter of last abdominal segment of male bearing at base a stout, slightly curved spine ... *spinosa*

Base of last abdominal segment of male without such a spine ... 5

5. (4) Dorsum of all abdominal segments of apterous forms with median shining black areas (that of the first segment may be very small) ... 6

Dorsum of abdomen of apterous forms with no, or at most four to six segments showing median shining black areas ... 7

6. (5) Posterior femur not projecting beyond apex of genital segments, *frontanalis*

Posterior femur projecting beyond apex of genital segments in both sexes ... *tenuipes*

7. (5) Posterior femora of most males enormously incrassate; posterior trochanter armed with several teeth ... *calopa*

Posterior femur of male never enormously incrassate; posterior trochanter unarmed ... 8

8. (7) Venter of abdomen of male with a prominent carina with abdomen depressed to form a trough on each side of the carina on last three or more segments ... 9

Venter of abdomen of male with no, or only slightly produced carina, or carina produced on last segment only ... 11

9. (8) Posterior femur of apterous male extending only to apex of genital segments. Dorsum of abdomen of female concave for last five segments ... *viriosa*

Posterior femur of apterous male extending well beyond apex of genital segments. Dorsum of abdomen of female convex or flat for last five segments ... 10

10. (9) Posterior femur with no spine longer than diameter of posterior tibia; posterior femur of male sharply reduced a little before apex ... *callida*

Posterior femur with at least one spine clearly longer than diameter of posterior tibia. Posterior femur of male tapering to apex ... *tenuipes*

11. (8) Connexiva margined in brown-orange; posterior femur with yellow to brown-yellow areas on both basal and apical portions with brown to black central area ... *deminuta*

Connexival margins not orange; posterior femur with no, or only basal light colored area ... 12

12. (11) Antennal segment II shorter than III ... 13

Antennal segment II longer than or subequal to III ... 22

13. (12) Entire pronotum behind vertex of head yellow to orange ... 14

Only anterior half of pronotum with yellow to orange band behind vertex of head ... 15

14. (13) Posterior margin of pronotum sinuate; connexiva of female reflexed; anterior trochanter of male unarmed ... *plumbea*

Posterior margin of pronotum straight; connexiva of female not reflexed; anterior trochanter of male armed with a long spur, *salina*

15.(13) Posterior femur of female unarmed, connexiva reflexed and contiguous for last segment (if only apterous males are at hand see next couplet) .... *janeira*

Posterior femur of female armed, connexiva may be reflexed but if so margins are not touching 16

16.(15) Intermediate trochanters yellow to white; venter of male with a small, blue-gray triangle on anterior margin of last abdominal segment .... *evidis*

Intermediate trochanters black or brown; venter of male without such markings as described above 17

17.(16) Posterior tibia of both male and female armed with subequal teeth along entire length (teeth of tibia of female may be weak, but are present) .... *tenuipes*

Posterior tibia of female unarmed along inner surface, posterior tibia of male may be armed with subequal teeth on basal one third or unarmed 18

18.(17) Tarsal segment II of intermediate leg subequal to III (seg. II more than four fifths as long as seg. III) 19

Tarsal segment II of intermediate leg shorter than III (seg. II approximately or less than four fifths as long as seg. III) 21

19.(18) Pro- and mesonotum flattened; venter gray-black .... *plana*

Pro- and mesonotum arched above; venter blue-gray 20

20.(19) Coxae of intermediate legs yellow; female without armature on posterior femur .... *janeira*

Coxae of intermediate legs dark brown to black; female with armed posterior femur .... *hambletoni*

21.(18) Posterior tibia unarmed at apex, apterous female with shining black spots on dorsum of last two abdominal segments, *tantilla*

Posterior tibia armed with a spur at apex (at least in apterous male), female with shining black spots on dorsum of last four or five abdominal segments .... *angustipes*

22.(12) Anterior trochanter of male armed with a stout, forwardly directed spur near apex; female with posterior one third of mesonotum depressed and dorsum of abdomen carinate on mid-line .... *paulana*

Anterior trochanter of male not armed; female not formed as above 23

23.(22) Posterior femur smaller in diameter than intermediate femur and armed with one small spine definitely beyond middle, followed by only 2 or 3 very small spines to apex 27

Posterior femur subequal to or larger in diameter than intermediate femur; armed near the middle with a moderate spine followed by 4 or more to apex or unarmed 24

24.(23) Posterior tibia unarmed; connexiva of apterous female reflexed for last 4 segments and meeting over dorsum of last abdominal segment .... *janeira*

Posterior tibia armed at least with a spur at apex; connexiva vertical or horizontal, but never meeting over dorsum of last abdominal segment 25

25.(24) Posterior tibia denticulate within, armed at apex with a spur. Venter of last abdominal segment of male with a median carina. Posterior femur with one long spine at middle followed by several sharp-pointed, curved spines to apex, *tenuipes*

Posterior tibia armed only with a spur at apex; venter of last abdominal segment of male without a median carina; posterior femur with one long spine at middle followed by several knoblike teeth 26

26.(25) Anterior femur black at base .... *versuta*

Anterior femur yellow at base .... *velocis*

27.(23) Posterior femur of male armed at apical two sevenths with one small spine followed by 2 or 3 much smaller spines to apex; posterior femur of female armed as in male .... *bisignata*

Posterior femur of male armed before apical one third with one small spine followed by one or two much smaller spines; posterior femur of female unarmed .... *modesta*

Rhagovelia angustipes Uhler

(Pl. III, fig. 1)

1894. *Rhagovelia angustipes* Uhler, Proc. Zool. Soc. London, p. 215.
1898. *Rhagovelia angustipes*, Champion, Biol. Centr. Amer., Het., vol. 2, p. 131 (included in key).
1900. *Rhagovelia angustipes*, Kirkaldy, Ent., vol. 34, p. 308 (records from Venezuela Puerto Cabello).
1931. *Rhagovelia angustipes*, Gould, Kansas Univ. Sci. Bull., vol. 20, p. 15 (records from Ecuador, Mexico and Panama; gives redescription).
1931. *Rhagovelia angustipes*, Drake and Harris, Pan Pacific Ent., vol. 8, p. 35 (record from Grenada, B. W. I.).

Size:	*Length*	*Width*
	3.00 mm. apterous male	1.00 mm. apterous male
	3.20 mm. apterous female	1.13 mm. apterous female

Color: General color black, clothed with fine, brown pubescence. Anterior half of pronotum yellow behind vertex of head, becoming pruinose behind eyes. Venter blue-grey (female) to black (male). Median area of venter of last abdominal segment and genital segments orange to brown. Base of antennae, base of anterior femora, anterior and posterior coxae and trochanters yellow. Margins of connexiva black. Apterous female with black shining spots on dorsum of last four or five abdominal segments.

Structural characteristics: Pronotum sutured off from mesonotum in apterous forms. *Apterous male:* anterior trochanter unarmed; anterior tibia not dilate, only slightly flattened on ventral surface. Pronotum wider than long (L. 12, W. 64); mesonotum truncate at apex (L. 45, W. 65) and indistinctly sutured off from metanotum in middle. Proportions of antennae: Seg. 1: II: III: IV:: 51: 25: 31: 32; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 105:

70: 34: 49; of posterior legs: 83: 87: 9: 21. Abdomen tapers to apex, angle of taper increasing for last three abdominal segments. Venter of last abdominal segment with median carina with segment slightly depressed to each side. Posterior trochanter unarmed. Posterior femur slightly incrassate (L. 83, W. 17) and armed with one long spine at the apical two fifths followed by eight or ten much smaller decreasing spines to apex. Posterior tibia straight and armed with only a feeble spur at apex. *Apterous female:* Pronotum formed as in male (L. 14, W. 67); metanotum as in male (L. 47, W. 78). Proportions of antennae: 48: 25: 30: 30; of intermediate legs: 103: 67: 32: 51; of posterior legs: 82: 85: 8: 20. Connexiva almost vertical over last three abdominal segments. No ventral carina. Posterior trochanter unarmed. Posterior femur not incrassate (L. 82, W. 13); armed at apical two fifths with one moderate spine followed by four or five much smaller spines to apex. Posterior tibia straight and seemingly unarmed. Dorsum of first two abdominal segments elevated, the remaining segments slightly depressed and forming a shallow trough. *Winged forms:* Proportions and armature similar to that of apterous forms. Pronotum not produced into spiniform process.

Comparative notes: This description is based on four apterous specimens which were compared with the type by Dr. H. B. Hungerford. This species closely resembles *R. evidis* Bacon, but differs in the orange instead of black venter of the last abdominal segment. Another close relative is *R. tantilla* Drake and Harris which has the posterior tibia unarmed in the apterous male, while that of *R. angustipes* Uhler has a spur at the apex. The genitalia of the male furnish the best diagnostic characters; the clasper of *R. angustipes* Uhler is not pointed at the tip, but is more or less pointed in each of the other two closely related species.

Data on types: This species was described from specimens taken on Grenada, British West Indies. Uhler's types of the Grenada collections are in the British Museum.

Data on distribution: Recorded from Grenada and St. Vincent in the British West Indies, Venezuela, Panama, Mexico, and Ecuador. Specimens have been examined from the following locality:

ECUADOR: Tena, near Oriente, Mar. 29-Apr. 10, 1923, F. X. Williams, 2 apterous males, 2 apterous females.

Rhagovelia bisignata Bacon

(Pl. III, fig. 2)

1948. *Rhagovelia bisignata* Bacon, Jour. Kansas Ent. Soc., vol. 21, No. 3, p. 71.

Size: *Length*	*Width*
3.23 mm. apterous male	1.26 mm. apterous male
3.82 mm. apterous female	1.33 mm. apterous female
3.52 mm. winged male	1.46 mm. winged male
3.82 mm. winged female	1.40 mm. winged female

Color: General color brown-black, clothed with brown pubescence. Head with impressed median line well defined, with two or three spots on each side, lateral converging lines not meeting at base to form perfect "V." Pronotum with broad transverse band of lighter gray on anterior three fourths with median area orange. Venter gray. Base of antennae, anterior and posterior coxae, and posterior trochanters pale yellow to brown-orange. Mesonotum of apterous forms with shining black triangle each side of median line with apex directed posteriorly. Margins of connexiva black. Apterous male with median area of venter of last segment and genital segments black; shining black spots on dorsum of last two or three abdominal segments. Apterous female with shining black spots on dorsum of last seven segments of abdomen.

Structural characteristics: Pronotum sutured off from mesonotum in apterous forms. *Apterous male:* anterior trochanter unarmed; anterior tibia not dilate and moderately arcuate. Pronotum wider than long (L. 14, W. 70); mesonotum approximately as long as wide (L. 70, W. 72) and nearly covering median part of metanotum. Proportions of antennae: Seg. I: II: III: IV:: 78: 48: 45: 38; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 170: 100: 65: 58; of posterior legs: 135: 144: 8: 24. Abdomen wide near base, tapering posteriorly, and angle of taper increasing at sixth abdominal segment. Venter with slight median carina which becomes pronounced on last abdominal segment. Posterior trochanter unarmed. Posterior femur not incrassate (L. 135, W. 11); armed with one brown spine at apical two sevenths and with two or three small spines from there to apex. Posterior tibia straight and unarmed, or armed only with small brown spur at apex. *Apterous female:* proportions of antennae: 75: 46: 47: 36; of intermediate legs: 165: 95: 63: 60; of posterior legs: 135: 144: 8: 24. Posterior femur armed as in male. *Winged forms:* Proportions of legs and antennae, and armature of posterior femur as in apterous forms. Pronotum not produced into a spiniform process.

Comparative notes: This species resembles *R. tenuipes* Champion from which it differs in the proportions of the legs, the armature of the posterior femur, and in the shape of the male clasper. The anterior trochanter of all forms of *R. bisignata* Bacon is black while that of *R. tenuipes* Champion is yellow. *R. bisignata* Bacon can be distinguished from all other *Rhagovelia* by the nature of the markings of the mesonotum when these markings are distinct.

Data on types: Holotype, apterous male; allotype, apterous female; holomorphotype, winged male, paratypes, 10 apterous males, 11 apterous females. Described from specimens from Tamazunchale, Mexico, S. L. P., July 20, '37, H. D. Thomas. Allomorphotype, winged female; collected at El Salto, Escuintla, Guatemala, 1934, F. X. Williams. All type specimens are in the Francis Huntington Snow Collections, University of Kansas.

Data on Distribution: In addition to the type series, specimens from the following localities have been studied (new records for major political areas are indicated with an asterisk):

COSTA RICA: San José, 6 & 7, 1931, Heinrich Schmidt, 4 apterous males, 4 apterous females.

GUATEMALA: Amatitlan, Ca. 8-11-05, 19 apterous males, 45 apterous females; Trib. Río Negro, N. Salama, 4-22-47, R. R. Miller, 1 apterous female; El Salto, Escuintla, 1934, F. X. Williams, 9 apterous males, 2 winged males, 19 apterous females, 4 winged females; Mazatenango, 3 Feb. 05 (J. R. de la Torre-Bueno Collection), 2 winged males, 9 winged females.

MEXICO: *Guerrero:* Acapulco, July 12, 1937, H. D. Thomas, 1 apterous male, 4 apterous females, 4 nymphs.

Michoacán: El Sabino, Uruapan, 7-24-36, H. D. Thomas, 32 apterous males, 28 apterous females.

* *Morelos:* Acatlipa, 1-1946, Coll. J. C. Shaw, el. 4000 ft., 3 apterous males, 8 apterous females; Cuernavaca, 7-8-36, H. D. Thomas, 2 winged females.

* *Vera Cruz:* Córdoba, 800 m.a.s.l., San Antonia R., A. Dampf, 3 winged males, 2 winged females.

Rhagovelia callida Drake and Harris

(Pl. III, fig. 3)

1935. *Rhagovelia callida* Drake and Harris, Proc. Biol. Soc. Washington, vol. 48, p. 34.

Size:	*Length*	*Width*
	3.47 mm. apterous male	1.47 mm. apterous male
	4.00 mm. apterous female	1.50 mm. apterous female

Color: General color brown-black, clothed with short brown pubescence. Pronotum with anterior half orange behind vertex of head, becoming pruinose behind eyes. Venter blue-gray. Base of antennae, margins of all acetabula, anterior and posterior coxae and trochanters yellow. Ventral portion of last abdominal segment and genital segments brown. Connexiva margined with band of rather shiny black, also shiny black spots in center of dorsum of last two abdominal segments of male, and on last three or four abdominal segments of female.

Structural characteristics: Pronotum in apterous forms sutured off from mesonotum. *Apterous male:* anterior trochanter unarmed; anterior tibia not dilate, slightly arcuate, flattened on inner surface. Pronotum much wider than long (L. 17, W. 80); mesonotum truncate at apex (L. 66, W. 82). Metanotum (L. 5, W. 87) almost covered in middle by apex of mesonotum. Proportions of antennae: Seg. I: II: III: IV:: 82: 50: 53: 43; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 178: 113: 68: 63; of posterior legs: 136: 117: 20: 27. Connexiva almost vertical. Venter with median carina which is very broad at base, narrowed and very prominent on last three abdominal segments and clothed with long hairs. Posterior trochanter unarmed. Posterior femur moderately incrassate (L. 136, W. 25), sharply reduced a little before apex, armed on apical two fifths with one row of twelve to fifteen short, blunt, subequal spines decreasing gradually to apex. Posterior tibia slightly arcuate, feebly denticulate within, armed at apex with blunt spur. *Apterous female:* Proportions of antennae: 83: 47: 51: 42; of intermediate legs: 178: 117: 68: 65; of posterior legs: 135: 132: 22: 25. Connexiva vertical, rounded at apex which is clothed with long hairs. Posterior femur not incrassate (L. 132, W. 17), armed at apical one third with one short, bent spine followed by several smaller, closely set, decreasing spines to apex. Posterior tibia straight, unarmed except at apex armed with feeble spur. *Winged forms:* unknown.

Comparative notes: This species resembles *Rhagovelia tenuipes* Champion from which it can be separated by the armature of the posterior femur, the formation of the posterior femur of the male, and the prominent and hairy ventral carina of the male.

Data on types: Holotype, apterous male, allotype, apterous female. The type series was taken from "Río Rimac, Lima, Peru, Sept. 1933," and is in the private collection of Dr. C. J. Drake. One apterous male, and one apterous female paratype are in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on distribution: In addition to the two paratypes from the type locality, specimens have been studied from the following localities:

PERU: Río Rimac, 17-44 kilometers east of Lima, Nov. 27-29, 1934, F. Woytkowski, 17 apterous males, 32 apterous females; Santa Clara, River Rimac, 17 km. E of Lima, Sept. 22-25, 1934, F. Woytkowski, 27 apterous males, 29 apterous females.

Rhagovelia calopa Drake and Harris

(Pl. III, fig. 4)

1927. *Rhagovelia calopa* Drake and Harris, Proc. Biol. Soc. Washington, vol. 40, p. 135.
1931. *Rhagovelia calopa,* Gould, Univ. of Kansas Sci. Bull., Vol. 20, p. 19 (redescribes apterous male).
1933. *Rhagovelia calopa,* Gould, Ann. Ent. Soc. America, vol. 26, p. 466 (records from British Honduras and notes variations in male, describes female).
1935. *Rhagovelia calopa,* Drake and Harris, Proc. Biol. Soc. Washington, vol. 48, p. 34 (record from Honduras, further description of female, describes winged forms, notes variations in male).

Size:	*Length*	*Width*
	3.46 mm. apterous male	1.46 mm. apterous male
	3.50 mm. apterous female	1.39 mm. apterous female
	3.85 mm. winged female	1.54 mm. winged female

Color: General color brown-black, clothed with golden pubescence. Pronotal band interrupted at middle by brown line, becoming pruinose at sides. Mesonotum slightly pruinose at apex. Metanotum pruinose around edges. Dorsum of first abdominal segment broadly pruinose except for median trapezoidal brown area. Dorsum of last five abdominal segments with progressively larger shining black, median spots. Connexival margin yellow-orange (female) to black (male). Venter blue-gray, with exception of last segment which has ventral black area. Base of antennae, proepisternum and proepimeron, all coxae, and anterior and posterior trochanters yellow. Posterior femur of male with narrow dorsoposterior yellow stripe and wider ventral yellow stripe running length of femur and merging near apex; female with only base of posterior femur yellow. Genital segments brown-black.

Structural characteristics: Pronotum sutured off from mesonotum in apterous forms. *Apterous male:* anterior trochanter unarmed. Anterior tibia slightly dilate and excavate on apical one fifth. Pronotum much wider than long (L. 15, W. 73); mesonotum truncate at apex (L. 57, W. 82); metanotum short on median line (L. 7, W. 90). Proportions of antennae: Seg. I: II: III: IV:: 68: 40: 34: 38; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 140: 112: 47: 58; of posterior legs: 122: 132: 10: 27. Abdomen tapers to apex, angle of taper increasing for last three segments. Venter without median carina. Posterior trochanter armed with one moderately long spine and from no to three smaller knoblike teeth. Posterior femur extends well beyond the apex of abdomen and is greatly incrassate (L. 130, W. 43); armed with anterior and posterior rows of spines as well as one median isolated spine located just beyond basal one third. Anterior row of spines of posterior femur runs total length of femur and is composed of small subequal spines; posterior row begins at approximately the middle with a group of two or three moderately long spines set very close together so that the bases are contiguous, this group of spines is offset toward posterior margin of femur and is followed by one row of four or five smaller, subequal spines to apex. Posterior tibia straight and armed on basal two thirds with two rows of teeth increasing slightly in size apically, apical one third with two of teeth of posterior row enlarged followed by two smaller teeth and a long spur at apex. There is much variation in degree of incrassation of posterior femur in different specimens. Posterior femur of some specimens hardly more incrassate than that of apterous female, in which case armature of posterior femur and tibia strongly resembles that of apterous female. *Apterous female:* pronotum formed much as in male (L. 15, W. 67); mesonotum truncate at apex (L. 52, W. 78); metanotum formed as in male (L. 6, W. 84). Proportions of antennae: 57: 36: 28: 32; of intermediate legs: 123: 95: 45: 55; of posterior legs: 100: 110: 8: 20. Abdomen formed as in male. Posterior trochanter unarmed. Posterior femur only slightly incrassate (L. 100, W. 18), armed just before apical one third with one long black-tipped spine followed by six smaller, rapidly decreasing darker spines to apex. Posterior tibia straight and armed on basal two fifths with several feeble teeth, apical three fifths unarmed except for slender spur at apex. *Winged forms:* pronotum marked as in apterous forms and wider than long (L. 95, W. 106); not produced into spiniform process at apex. Proportions and armature similar to apterous forms. Wings extend slightly beyond apex of abdomen.

Comparative notes: This species resembles *Rhagovelia femoralis* Champion in general characteristics, but does not agree in the nature of the pronotum which is sutured off from mesonotum in *R. calopa* Drake and Harris while it is "abbreviated and rounded behind" in *R. femoralis* Champion.

Data on types: The holotype is an apterous male from Los Amates, Guatemala, Jan. 16, 1905, and is in the personal collection of Dr. C. J. Drake.

Data on distribution: Recorded from British Honduras, Guatemala, and Honduras. The following specimens have been examined (new records for major political areas are indicated with an asterisk):

BRITISH HONDURAS: Río Grande, Nov. 1931, J. J. White, 87 apterous males, 97 apterous females; Punta Gorda, 1932, J. J. White, 16 apterous males, 7 apterous females; Río Grande, Jan. 1932, J. J. White, 3 apterous males, 5 apterous females, 3 nymphs.

* BRITISH WEST INDIES: * *Trinidad:* 9-27-31, W. E. Broadway, 5 apterous males, 2 apterous females.

* CANAL ZONE: Ft. Clayton, Capt. R. F. Edwards, 1 apterous male, 1 apterous female.

* COLOMBIA: Aracataca, 1912, II, Ujhelyi (Exchange from Budapest Mus.), 1 apterous male, 2 winged females.

GUATEMALA: Gualan, 23-1-5 (J. R. de la Torre-Bueno collection), 4 apterous males, 4 apterous females; Los Amates, 16-1-05 (J. R. de la Torre-Bueno collection), 10 apterous males, 16 apterous females.

HONDURAS: Lancetilla, 3-22-36, John Deal, 2 apterous males, 10 apterous females; Tela, March 8, 1936, John Deal, 28 apterous males, 52 apterous females.

* MEXICO: * *Chiapas:* Tuxtla Gutierrez, Aug. 27, 1937, H. D. Thomas, 1 apterous male; San Vicente, 4-38, 540 M, Octavio Utrilla, L., 2 apterous males, 1 apterous female; Hda. La Libertad, Sept. 1, 1937, H. D. Thomas, 1 apterous female.

* PANAMA: Coiba, August, 1924, L. E. Cheesman (Exchange from British Museum), 1 apterous female.

VENEZUELA: San Esteban, Jan. 15, 1940, Pablo J. Anduze, 5 apterous males, 6 apterous females; Porto Cabello, Río do Pasoreal, 2 apterous males, 1 apterous female.

Rhagovelia deminuta Bacon

(Pl. III, fig. 5)

1948. *Rhagovelia deminuta* Bacon, Jour. Kansas Ent. Soc., vol. 21, no. 3, p. 72.

Size:	*Length*	*Width*
	2.42 mm. apterous male	0.97 mm. apterous male
	2.80 mm. apterous female	1.03 mm. apterous female

Color: General color gray-black, clothed with gold-brown pubescence. Pronotum orange with gray spots at each lateral margin. Venter gray. Base of antennae, base of anterior femora, all coxae and trochanters yellow. Posterior femora with distal and apical quarters yellow to tan and middle half of femur brown. Venter of last abdominal segment and genital segment brown to orange-brown. Margins of connexiva orange.

Structural characteristics: Pronotum sutured off from mesonotum in apterous forms. *Apterous male:* anterior trochanter unarmed; anterior tibia slightly dilate and flattened on the ventral surface. Pronotum wider than long (L. 8, W. 48); mesonotum truncate (L. 42, W. 57) and nearly covering median portion of metanotum. Proportions of antennae: Seg. I: II: III: IV:: 43: 22: 28: 32; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 100: 75: 38: 43; of posterior legs: 75: 75: 2: 16. Abdomen tapers evenly to apex. Abdomen without ventral carina. Posterior trochanter unarmed. Posterior femur moderately incrassate (L. 75, W. 20) and armed with one long, yellow, brown-tipped spine at middle and from there to apex with six or seven decreasing spines. Posterior tibia not sinuate and armed on basal half with several very short teeth; armed at apex with small spur. *Apterous female:* proportions very similar to the male. Proportions of antennae: 45: 22: 28: 31; of intermediate legs: 100: 75: 40: 46; of posterior legs: 80: 80: 2: 19. Posterior femur not quite so incrassate as in the male (L. 80, W. 20); armed as in the male. Posterior tibia armed as in the male. *Winged forms:* unknown.

Comparative notes: This species most nearly resembles *Rhagovelia spinosa* Gould, but does not have the ventral abdominal spine which characterized *R. spinosa* Gould. It can be identified at a glance by the light colored area at the apical one fourth of the posterior femur.

Data on types: Holotype, apterous male; allotype, apterous female; paratypes, 87 apterous males and 49 apterous females. Described from specimens labeled: "British Guiana, Supuruni Creek, August 12, 1937, S. Harris." All type specimens are in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on distribution: Known only from type series.

Rhagovelia evidis Bacon

(Pl. III, fig. 6)

1948. *Rhagovelia evidis* Bacon, Jour. Kansas Ent. Soc., vol. 21, no. 3, p. 73.

Size:	*Length*	*Width*
	2.50 mm. apterous male	1.03 mm. apterous male
	2.93 mm. apterous female	1.13 mm. apterous female

Color: General color black, clothed with very fine brown pubescence. Head with usual impressed lines. Pronotum gray with faint orange band at middle. Venter blue-gray. Base of antennae, base of anterior and very small portion of base of posterior femora, all coxae and trochanters yellow. Posterior and intermediate tibiae and all tarsal segments brown. Margins of connexiva black. Apterous male with shining black spot on dorsum of last abdominal segment; venter of last abdominal segment black with small blue-gray triangle with base on anterior margin of segment. Apterous female with shining black spot on dorsum of last two abdominal segments.

Structural characteristics: Pronotum sutured off from mesonotum in apterous forms. *Apterous male:* anterior trochanter armed only with small tuft of dark brown hair; anterior tibia not dilate, only very slightly flattened on ventral surface. Pronotum wider than long (L. 12, W. 59); mesonotum truncate (L. 47, W. 60), and nearly covering median portion of metanotum. Proportions of antennae: Seg. I: II: III: IV:: 50: 27: 30: 29; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 106: 73: 40: 48; of posterior legs: 83: 83: 6: 16. Abdomen tapers evenly to apex. Venter of last abdominal segment with slight carina extending only on apical half with segment slightly depressed to each side. Posterior trochanter unarmed. Posterior femur slightly incrassate (L. 83, W. 17) and armed with one long, black spine at middle, followed by six or seven rapidly decreasing spines from there to apex. Posterior tibia straight and armed only with a small spur at apex. *Apterous female:* proportions of antennae: 50: 27: 32: 29; of intermediate legs: 110: 75: 40: 48; of posterior legs: 83: 90: 6: 18. Connexiva slightly reflexed over last three abdominal segments. No ventral carina. Posterior trochanter unarmed. Posterior femur less incrassate than in male (L. 83, W. 15); armed slightly beyond middle with one slender spine and from there to apex with approximately four decreasing spines. Posterior tibia straight and unarmed. Dorsum of first two abdominal segments arched above; third to sixth depressed forming shallow trough. *Winged forms:* unknown.

Comparative notes: This species resembles *Rhagovelia tantilla* Drake and Harris from which it can be separated by its smaller size, the spur on the posterior tibia, the color of the intermediate trochanters, the structure of the last ventral abdominal segment of the male and the shape of the male claspers which are more pointed than those of *R. tantilla.*

Data on types: Holotype, apterous male; allotype, apterous female; paratypes, 5 apterous males and 8 apterous females. Described from specimens labeled: "Brazil, S. A. 9-25, 10-17-36 A. M. Olalla Vic. Santo Antonia, River Eiru No. 3712." All type specimens are in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on distribution: In addition to the type specimens, specimens from the following localities have been examined (new records for major political areas are indicated with an asterisk).

* Peru, S. A.: Dept. San Martín, Region Tarapoda, 820 m.a.s.l., brook in village, Feb. 8, 1947, Felix Woytkowski, 4 apterous males, 7 apterous females; Dept. Huanuco, Vic. of Afilador, Jungle brooks, 800 m.a.s.l., June 8-9, F. Woytkowski, 1 apterous male.

Rhagovelia festae Kirkaldy

1899. *Rhagovelia festae* Kirkaldy, Bol. Mus. Zool. Anat. Comp. Torino, vol. 14, 350:4.
1901. *Rhagovelia festae,* Kirkaldy, Ento., vol. 34, p. 308 (mentions in key).
1931. *Rhagovelia festae,* Gould, Kansas Univ. Sci. Bull., vol. 20, p. 31 (notes occurrence in Ecuador).

This species is not represented in the material in the Francis Huntington Snow Entomological Collections of the University of Kansas. The original description is quoted below.

"Apterous. Fusiform, a little dilated.

"Head anteriorly truncate, with a deeply impressed inverted arrow (↓) on the notacephalon, a large impressed point on each side of the posterior margin of the head. Head and nota minutely punctured. First antennal segment curved, one-half longer than second, which is one-fourth longer than the 3rd; 4th fusiform, one-half longer than 3rd. Penultimate segment of rostrum reaching beyond the base of prosternum. Pronotum not carinate, distinctly sutured off from mesonotum, the latter rounded basally covering the mesonotum (except basally at the sides). Mesosternum with a curved, diagonal carina extending from the interobasal margin of anterior ambulacra almost to the base of intermediate ambulacra. Anterior coxae very large and round, femora a little shorter than tibiae, about 4 times as long as tarsi.

"Female. Abdomen not carinate ventrally, 6th segment (ventral) about 2ce as long as 5th, apical margin subsinuate. Posterior femora not incrassate, not dentate: tibiae not dentate.

"Length 2.6 mill.

"Ecuador—Foreste Río Peripa.

"Dark slate grey, slightly covered with yellowish pubescence. Antennae (except the yellowish white base of first segment) and legs (except brownish coxae and yellowish-brown pilosity) shining bluish-black. Antenniferous tubercules shining brownish.

"I have great pleasure in naming this interesting bug in honour of Dr. Festa, the intrepid traveller."

Comparative notes: This species apparently resembles *R. spinosa* Gould and is from the same general area. However, the antennal proportions for the two species are different, and the ventral spine on the male of *R. spinosa* Gould at once sets it apart from *R. festae* Kirkaldy.

Data on distribution: Recorded only from Ecuador.

Rhagovelia fontanalis Bacon

(Pl. III, fig. 7)

1948. *Rhagovelia fontanalis* Bacon, Jour. Kansas Ent. Soc., vol. 21, no. 3, p. 74.

Size:	*Length*	*Width*
	3.45 mm. apterous male	1.13 mm. apterous male
	3.86 mm. apterous female	1.26 mm. apterous female
	4.33 mm. winged male	1.39 mm. winged male
	4.45 mm. winged female	1.46 mm. winged female

Color: General color dark brown, clothed with fine brown pubescence. Head with usual impressed lines. Pronotum gray with median area orange; posterior third of pronotum same color as mesonotum. Margins of connexiva black. Venter blue-gray. Basal half of first segment of antennae, coxae, anterior and posterior trochanters, basal half of anterior femora, basal half of intermediate trochanter, and basal fifth of posterior femora yellow to yellow-brown. Broad, shining, black spots occupy nearly the whole dorsum of abdominal segments on all but first segment; the markings of first segment usually smaller than that of remaining segments, or may be absent. Venter of last abdominal segment and genital segments of male orange, of female brown to black.

Structural characteristics: Pronotum sutured off from mesonotum in apterous forms. *Apterous male:* anterior trochanter unarmed. Anterior tibia slightly dilate and excavate on apical one fifth. Pronotum much wider than long (L. 15, W. 65); mesonotum also wider than long (L. 55, W. 67) and nearly covering metanotum. Proportions of antennae: Seg. I: II: III: IV:: 60: 34: 40: 36; of intermediate legs. Fem.: Tib.: Tars. II: Tars. III:: 123: 87: 41: 50; of posterior legs: 105: 110: 11: 22. Abdomen tapers to apex, angle of taper increasing for last three segments. Venter without median carina. Posterior trochanter unarmed. Posterior femur very slightly incrassate (L. 105, W. 16), no wider than base of intermediate leg; armed with one curved spine at middle, followed with four or five short spines to apex. Posterior tibia straight and unarmed. *Apterous female:* proportions of antennae: 63: 34: 39: 37; of intermediate legs: 134: 93: 45: 54; of posterior legs: 108: 115: 12: 23. Posterior femur slightly incrassate; armed slightly beyond middle with one short spine, and from there to apex with five or six very short spines, or may be armed only with spine slightly beyond middle, or unarmed. Posterior tibia straight and without spur at the apex. *Winged forms:* Proportions of legs and antennae, and armature of posterior femora same as for apterous forms. Tips of wings extend well over apex of abdomen. Pronotum not produced into elongate process.

Comparative notes: This species resembles *Rhagovelia evidis* Bacon from which it can be separated by its proportions, and the armature of the posterior femur. The genitalia are also quite distinct.

Data on types: Holotype, apterous male; allotype, apterous female; holomorphotype, winged male; allomorphotype, winged female; paratypes, 6 apterous males, 12 apterous females; paramorphotypes, 7 winged males, 5 winged females. Described from series labeled: "Peru, S. A., Vic. Sani Beni, 840 m. a. s. l., Canal supplying drinking water, Oct. 10, 1935, F. Woytkowski, Field Note 3562." All type specimens are in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on distribution: In addition to the type specimens, specimens from the following localities have been examined:

PERU: Vic. Sani Beni, 840 m. a. s. l., brooks and pools of Sani Beni, Aug. 31, 1935, F. Woytkowski, Field Note 3560, 12 apterous males, 1 winged male, 6 apterous females, 1 winged female; Vic. San Beni, 840 m.a.s.l., River Sani Beni, Sept. 5, 1935, F. Woytkowski, Field Note 3551, 3 apterous males, 2 winged males, 6 apterous females, 2 winged females; Vic. Sani Beni, 840 m.a.s.l., in River Sani Beni, July-August, 1935, F. Woytkowski, Field Note 3553b, 1 apterous female, 1 winged female; Vic. Sani Beni, 840 m.a.s.l., tiny brook in jungle, Oct. 10, 1935, F. Woytkowski, Field Note 3557, 1 apterous female; Vic. Sani Beni, 840 m.a.s.l., from river, Oct. 9, 1935, F. Woytkowski, Field Note 3548, 1 winged male, 1 winged female; Vic. Sani Beni, 840 m.a.s.l., brook on open cultivated land, Oct. 12, 1935, F. Woytkowski, Field Note 3566, 2 apterous males; Vic. Sani Beni, 850 m.a.s.l., River Sani Beni and adj. pools, Aug. 5, 1935, F. Woytkowski, Field Note 3553d, 1 apterous female; Vic. Río Negro, 790 m.a.s.l., River R. Negro, Oct. 28, 1935, F. Woytkowski, Field Note 3568, 1 apterous female; Vic Río Negro, 790 m.a.s.l., in R. Negro, Nov. 4, 1935, F. Woytkowski, Field Note 3553e, 1 apterous male, 1 apterous female; Vic. Río Negro, 790 m.a.s.l., shady brook, jungle, bed of clay, Oct. 29, 1935, F. Woytkowski, Field Note 3564, 1 winged male, 1 apterous female; Vic. Río Negro, 790 m.a.s.l., River Río Negro, Nov. 4, 1935, F. Woytkowski, Field Note 3550, 4 apterous males, 1 winged male; Vic. San Pedro, 900 m.a.s.l., jungle pools, May 15-19, 1935, F. Woytkowski, 3 apterous males; Vic. of San Pedro, 900 m.a.s.l., pools and ponds, May 15-19, 1935, F. Woytkowski, 1 apterous female; Roqueron del Padre, Abad Cordulern, Azut, Dept. Loreto, 1 apterous male; Dept. Ayacucho, Prov. La Mar. Sivia, jungle, 790 m.a.s.l., jungle brooks, June 24-30, 1941, F. Woytkowski, No. 425, 2 apterous females, 1 winged female; Dept. Ayacucho Prov. La Mar. Sivia, jungle, 790 m.a.s.l., stagnant pools, June 24-30, 1941, F. Woytkowski, No. 426, 1 apterous male, 3 apterous females; Dept. Ayacucho, Prov. La Mar. Sivia, jungle, 790 m.a.s.l., stagnant boggy pools, June 18-19, 1941, F. Woytkowski, No. 428, 5 apterous males, 6 apterous females, 1 winged female; Dept. Ayacucho, Prov. La Mar. Sivia, jungle, 790 m.a.s.l., slow flowing brooks, June 16, 1941, F. Woytkowski, No. 429, 11 apterous males, 1 winged male, 10 apterous females; Satipo, XII, '42, Pedro Paprzycki, 1 apterous male, 6 apterous females; Satipo, Nov., 1942, Pedro Paprzycki, 4 apterous males, 11 apterous females; Satipo, VII and VI, '42, Pedro Paprzycki, 33 apterous males, 35 apterous females; Dept. Huánuco, Vic. of Afilador, jungle brooks, 800 m.a.s.l., June

8-9, 1937, F. Woytkowski, No. 3767, 4 apterous females; Vic. San Pedro, 900 m.a.s.l., muddy ponds, May 15-19, 1935, F. Woytkowski, 1 apterous male; Aguaitia, Dept. Loreto, IX-1-46, F. Woytkowski, 5 apterous females.

Rhagovelia hambletoni Drake and Harris

(Pl. III, fig. 8)

1933. *Rhagovelia hambletoni* Drake and Harris, Proc. Biol. Soc. Washington, vol. 46, p. 48.

Size:	*Length*	*Width*
	2.93 mm. apterous male	1.06 mm. apterous male
	3.40 mm. apterous female	1.13 mm. apterous female

Color: General color black, clothed with brown pubescence. Anterior half of pronotum orange behind vertex of head, orange band interrupted at middle with fine brown line, pronotum pruinose behind eyes. Margins of connexiva shining black. Venter blue-gray, last segment black beneath. Base of antennae, margins of all acetabulae, anterior and posterior coxae and trochanters, and base of anterior femora yellow. Dorsum of abdomen with apical three segments with median shining black spots.

Structural characteristics: Pronotum sutured off from mesonotum in apterous forms. *Apterous male:* anterior trochanter unarmed. Anterior tibia slightly dilate, flattened on inner surface. Pronotum much wider than long (L. 12, W. 65), mesonotum truncate at apex (L. 50, W. 67). Proportions of antennae: Seg. I: II: III: IV:: 52: 30: 34: 33; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 122: 84: 47: 50; of posterior legs: 87: 98: 7: 18. Abdomen tapering evenly to apex. Slight indication of ventral carina except on apical half of last segment where abdomen is slightly depressed to each side. Posterior trochanter unarmed. Posterior femur only slightly incrassate (L. 87, W. 15), armed just after middle with one long spine followed by seven or eight rapidly decreasing, much shorter spines to apex. Posterior tibia straight and armed with a short spur at apex. *Apterous female:* pronotum formed as in male (L. 13, W. 65); mesonotum depressed for posterior one third (L. 50, W. 75); metanotum flat in middle and sloping sharply upwards at side. Proportions of antennae: 52: 30: 35: 34; of intermediate legs: 127: 88: 48: 52; of posterior legs: 95: 103: 8: 18. Abdomen tapering rather evenly to apex with connexiva strongly reflexed for last four segments, and clothed at apex with compact group of long hairs. Venter with slight median carina extending to last abdominal segment. Posterior trochanter unarmed. Posterior femur only slightly incrassate (L. 95, W. 12) and armed at apical one third with one slender, bent spine followed by three or four much smaller, decreasing teeth to apex. Posterior tibia straight and armed at apex with an inconspicuous spur. *Winged forms:* unknown.

Comparative notes: This species resembles *Rhagovelia plana* Drake and Harris but lacks the flattened pronotum which characterizes that species, also the nature of the female connexiva will serve to separate it from that form.

Data on types: The holotype of this species is an apterous male; the allotype an apterous female. The paratypes are also apterous forms. These specimens were collected at Vicosa, Minas Geraes, Brazil on June 6, 1932 by Hambleton. The type series is in the personal collection of Dr. C. J. Drake. There are two apterous male and two apterous female paratypes in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on distribution: Known only from the type series.

Rhagovelia imitatrix Bacon

(Pl. III, fig. 9)

1948. *Rhagovelia imitatrix* Bacon, Jour. Kansas Ent. Soc., vol. 21, no. 3, p. 76.

Size:	*Length*	*Width*
	3.40 mm. apterous male	1.26 mm. apterous male
	4.06 mm. apterous female	1.70 mm. apterous female
	3.80 mm. winged male	1.66 mm. winged male
	4.32 mm. winged female	1.73 mm. winged female

Color: General color black, clothed with very fine gray-brown pubescence. Head with usual impressed lines well defined. Pronotum with anterior half gray with median orange area. Venter blue-gray; last abdominal segment and genital segments black. Base of first antennal segment, base of femora, and all coxae yellow. Occasionally one small, shining, black spot on dorsum of last abdominal segment. Winged forms slightly darker than apterous forms; wings dark brown.

Structural characteristics: Pronotum sutured off from mesonotum in apterous forms. *Apterous male:* Anterior trochanter unarmed. Anterior tibia arcuate; slightly flattened at apex. Pronotum much wider than long (L. 16, W. 75); mesonotum truncate (L. 80, W. 75) and nearly reaching posterior border of metanotum. Proportions of antennae: Seg. I: II: III: IV:: 80: 48: 48: 41; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 185: 125: 70: 60; of posterior legs: 125: 180: 10: 22. Angle of taper of abdomen increasing on last three segments. Venter of last abdominal segment with depression on each side of median ridge. Posterior trochanter unarmed. Posterior femur not incrassate (L. 125, W. 20) and unarmed. Posterior tibia extremely elongate, straight and not armed. *Apterous female:* proportions of antennae: 77: 45: 45: 40; of intermediate legs: 187: 123: 64: 62; of posterior legs: 129: 168: 10: 27. Posterior trochanter, femur, and tibia the same as in male. *Winged forms:* proportions of legs and antennae similar to apterous forms. Posterior femur as in apterous forms. Humeri prominent. Wings extending well beyond apex of abdomen. Venter with last segment as in apterous forms. Pronotum not produced into spiniform process.

Comparative notes: This species resembles *Rhagovelia longipes* Gould from which it differs in the proportions of the antennae and the male claspers which are broad and shovel-shaped rather than narrowed toward the apex as in *Rhagovelia longipes* Gould.

Data on types: Holotypes, apterous male; allotype, apterous female; holomorphotype, winged male; allomorphotype, winged female; paratypes, 88 apterous males, 127 apterous females; paramorphotypes, 1 winged male, 1 winged female. Described from specimens labeled: "Perú, S. A. Sept. 6-1937, F. Woytkowski, No. 3784, Dept. of Huánuco, Vic. of Huánuco Andes, 2000 m.a.s.l., In streamlet." All type specimens are in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on distribution: In addition to the type specimens, specimens from the following localities have been examined:

PERU: Dept. of Huánuco, Vic. Huánuco, Río Huallaga, subtropical, May 24, 1937, F. Woytkowski, No. 3770, 1 apterous male; Dept. of Huánuco, Vic. Leonpampa Jungle, 800 m.a.s.l., forest pools, Dec. 11, 1937, F. Woytkowski, No. 387, 2 apterous males, 7 apterous females; Rîo Paucartambo, Bot. 1934 of Gertrude E. Nelson, 37 apterous males, 59 apterous females; Vic. San Pedro, 900 m.a.s.l., muddy ponds, May 15-29, 1935, F. Woytkowski, 1 apterous female.

Rhagovelia longipes Gould

(Pl. III, fig. 10)

1931. *Rhagovelia longipes* Gould, Kansas Univ. Sci. Bull., vol. 20, p. 35.
1933. *Rhagovelia longipes*, Gould, Ann. Ent. Soc. America, vol. 26, p. 469 (records an additional specimen from Ecuador).
1935. *Rhagovelia longipes*, Drake and Harris, Proc. Biol. Soc. Washington, vol. 48, p. 35 (describes apterous forms; record from Perú).

Size:	*Length*	*Width*
	3.00 mm. apterous male	1.40 mm. apterous male
	3.50 mm. apterous female	1.52 mm. apterous female
	3.05 mm. winged male	1.46 mm. winged male
	3.45 mm. winged female	1.50 mm. winged female

Color: General color gray-black, covered with brown pubescence. Pronotum with narrow orange band behind vertex of head. Venter blue-gray, median portion of venter of last abdominal segment black. Base of first antennal segment yellow. All coxae and trochanters dark brown to black on most specimens, anterior and posterior coxae and trochanters brown to yellow on some forms. Sometimes one small, shining, black spot present on dorsum of last abdominal segment. Wings brown.

Structural characteristics: Pronotum in apterous forms sutured off from mesonotum. *Apterous male:* anterior trochanter unarmed; anterior tibia not dilate, slightly arcuate. Pronotum wider than long (L. 13, W. 72); mesonotum depressed slightly in center (L. 69, W. 75) and truncate at apex. Proportions of antennae: Seg. I: II: III: IV:: 66: 32: 45: 45; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 178: 117: 73: 51; of posterior legs: 110: 172: 5: 19. Connexiva practically parallel at first, rather abruptly narrowing for last three segments of abdomen. Venter with ventral carina only on posterior half of last abdominal segment and first genital segment where abdomen is slightly depressed on each side. Posterior trochanter unarmed. Posterior femur not incrassate, smaller than base of intermediate leg. Posterior femur unarmed. Posterior tibia long, straight, and unarmed at apex. *Apterous female:* Pronotum, mesonotum, anterior legs, and connexivum formed as in male. Proportions of antennae, 65: 28: 40: 38; of intermediate legs: 167: 110: 63: 55; of posterior legs: 106: 146: 8: 24. Venter without ventral carina; more tumid than in male. Posterior leg as in male. *Winged forms:* pronotum with slight median carina and rounded posteriorly (L. 97, W. 98). Appendages formed and proportioned similarly to apterous forms.

Comparative notes: This species may be easily separated from all *Rhagovelia* except *R. imitatrix* Bacon by the elongate nature of the legs (in particular by the elongate posterior tibia), and by the unarmed posterior femora of all forms. It differs from *R. imitatrix* Bacon in the proportions of the antennae and shape of the male clasper which is more sharply-pointed than the shovel-shaped clasper of *R. imitatrix* Bacon.

Data on types: The holotype is a winged male, the allotype a winged female. There is also one winged female paratype. The type series bears the following data: "Tena, Ecuador, Vicinity Oriente, March 29, 1923, F. X. Williams." All type specimens are in the Francis Huntington Snow Entomological Collections, University of Kansas.

Date on distribution: In addition to the type series the following specimens have been examined:

PERU: Dept. San Martín, Vic. Roija, jungle, 900 m.a.s.l., Oct. 11-22, 1936, F. Woytkowski, No. 3722, 2 apterous males, 7 apterous females; Dept. Cajamarco, Andes, 1179 m.a.s.l., River Marañon, Vic. of Balsas, June 26-29, '36, F. Woytkowski, No. 3634, 14 apterous males, 12 apterous females; Dept. Huánuco, Vic. of Afilador, shady jungle, 670 m.a.s.l., June 10-30, 1937, F. Woytkowski, No. 3766, 8 apterous females, 2 winged females; Dept. Loreto, Aguaitia, IX, 1, '46, F. Woytkowski, 27 apterous males, 21 winged males, 25 apterous females, 17 winged females; Dept. Loreto, Aguaitia, IX, 19, '46, F. Woytkowski, 17 apterous males, 27 winged males, 26 apterous females, 13 winged females.

Rhagovelia modesta sp. nov.

(Pl. III, fig. 11)

Size:	*Length*	*Width*
	3.15 mm. apterous male	1.26 mm. apterous male
	3.45 mm. apterous female	1.43 mm. apterous female

Color: General color black, clothed with a gray pubescence. Pronotum with an orange band on anterior one half behind vertex of head, becoming pruinose behind the eyes. Dorsum of last one or two abdominal segments with a shining black spot. Margins of connexiva black. Venter blue-gray; venter of last abdominal segment black beneath. Base of antennae, margins of all acetabulae yellow. Anterior coxae and posterior coxae in part brown.

Structural characteristics: Pronotum sutured off from mesonotum in apterous forms. Apterous male: anterior trochanters unarmed; anterior tibia straight and slightly flattened on apical one third beneath. Pronotum much wider than long (L. 16, W. 70); mesonotum (L. 60, W. 70) indistinctly sutured off from metanotum. Proportions of antennae: Seg. I: II: III: IV:: 77: 53: 42: 35; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 156: 108: 63: 55; of posterior legs: 118: 127: 9: 20. Abdomen tapering more abruptly for last three segments. Venter without median carina. Posterior trochanter unarmed. Posterior femur not incrassate (L. 118, W. 13) and armed before apical one third with one small bent spine followed by one or two much smaller, widely-spaced spines to apex. Posterior tibia straight and seemingly unarmed. *Apterous female:* pronotum formed as in male (L. 17, W. 73); mesonotum slightly emarginate on midline (L. 57, W. 87). Proportions of antennae: 66: 42: 37: 33; of intermediate legs: 143: 95: 56: 55; of posterior legs: 103: 120: 10: 22. Dorsum of abdomen concave after first two or three segments. Abdomen tapering rather evenly to apex. Connexiva tapering evenly to next to last segment, last two segments of connexiva parallel. Venter of abdomen without median carina. Posterior trochanter unarmed. Posterior femur not incrassate (L. 103, W. 11) and unarmed. Posterior tibia straight and unarmed. *Winged forms:* unknown.

Comparative notes: This species resembles *R. bisignata* Bacon. *R. modesta* sp. nov. can be separated from *R. bisignata* Bacon by the armature of the posterior femur of the male with the long spine before the apical one third and the lack of armature of the posterior femur of the female. The concave dorsum of the apterous female will also serve to differentiate the two species.

Data on types: Holotype, apterous male, allotype, apterous female; paratypes, 5 apterous males, 9 apterous females. The type specimens bear the following data on collection: "Brazil, S. A. III. 28-48, Antenor. Ariro Angra dos Reis Estado do Rio, Leitao de Carvalho."

Data on distribution: Known only from type series.

Rhagovelia plana Drake and Harris

(Pl. III, fig. 12)

1933. *Rhagovelia plana* Drake and Harris, Proc. Biol. Soc. Washington, vol. 46, p. 49.

Size:	*Length*	*Width*
	2.86 mm. apterous male	1.13 mm. apterous male
	3.12 mm. apterous female	1.20 mm. apterous female

Color: General color black, clothed with fine golden pubescence. Pronotum with narrow orange band behind vertex of head. Dorsum of last abdominal segment with central, black, shining spot. Venter dark gray. Venter of last abdominal segment black. Genital segments brown. Bases of first antennal segments, margins of all acetabulae, anterior and posterior coxae and trochanters yellow.

Structural characteristics: Pronotum sutured off from mesonotum in apterous forms. *Apterous male:* anterior trochanter unarmed; anterior tibia straight, not dilate, slightly flattened on ventral surface. Pronotum wider than long (L. 12, W. 62); mesonotum truncate at apex (L. 50, W. 67), flattened and nearly covering median portion of metanotum. Proportions of antennae: Seg. I: II: III: IV:: 55: 27: 32: 33; of intermediate legs: Fem.: Tib.: Tars. II: Tars.

III:: 110: 75: 47: 46; of posterior legs: 84: 95: 4: 16. Abdomen tapering evenly to apex. Venter without median carina. Posterior trochanter unarmed. Posterior femur moderately incrassate (L. 84, W. 15); armed just after middle with one long, bent spine followed by approximately ten decreasing spines to apex. Posterior tibia straight; armed with several inconspicuous teeth on basal one third and an indistinct spur at apex. *Apterous female:* pronotum formed as in apterous male; mesonotum arched slightly more than in apterous male. Proportions of antennae: 50: 25: —: —; of intermediate legs: 107: 73: 45: 48; of posterior legs: 86: 95: 6: 16. Abdomen tapers evenly to apex; connexiva almost vertical. Posterior femur not as incrassate as in male (L. 86, W. 12), armed at apical two fifths with one long bent spine followed by approximately five rapidly decreasing spines to apex. Posterior tibia straight and seemingly unarmed. *Winged forms:* unknown.

Comparative notes: This species resembles *R. hambletoni* Drake and Harris from which it can be separated by the dorsoventral flattening of the pro- and mesonotum. *R. plana* Drake and Harris also is close to *R. tantilla* Drake and Harris, but can be separated from that species by the differing proportions of the legs as well as by the depressed form of the body.

Data on types: The holotype is an apterous male, the allotype an apterous female. The paratypes are numerous apterous males and females. The collection data on the type series is as follows: "Punta Gorda, Br. Honduras, Feb., 1932." In addition to the type material in the personal collection of Dr. C. J. Drake, there are three apterous male and two apterous female paratypes of this species in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on distribution: Known only from the type series.

Rhagovelia plumbea Uhler

(Pl. III, fig. 13)

1894. *Rhagovelia plumbea* Uhler, Proc. Zool. Soc. London, p. 217.
1896. *Rhagovelia plumbea,* Lethierry and Severin, Catalogue Général des Hémip., Tome III, p. 55.
1898. *Trochopus marinus* Carpenter, Ent. Mon. Mag. vol. 24, p. 78.
1900. *Rhagovelia plumbea,* Kirkaldy, Ento., vol. 33, p. 72 (places *Trochopus marinus* as a synonym of *R. plumbea*).
1901. *Rhagovelia plumbea,* Kirkaldy, Ento., vol. 34, p. 308.
1910. *Rhagovelia plumbea,* Banks, Catalogue of Nearctic Hemiptera Heteroptera, p. 28.
1914. *Rhagovelia plumbea,* Barber, Bull. American Mus. Nat. Hist., vol. 33, p. 499 (records from Florida).
1917. *Rhagovelia plumbea,* Van Duzee, Catalogue of Hemip. of America N. of Mexico, p. 435.

1919. *Rhagovelia plumbea,* Hungerford, Kansas Univ. Sci. Bull., vol. 11, p. 130 (quotes original description; records from Florida).
1923. *Rhagovelia plumbea,* Torre-Bueno, *In* Connecticut Geo. & Nat. Hist. Surv. Bull., vol. 34, p. 418 (records from Florida).
1926. *Rhagovelia plumbea,* Blatchley, Heter. of Eastern North America, p. 999 (gives redescription; records from Florida).
1927. *Rhagovelia plumbea,* Drake and Harris, Proc. Biol. Soc. Washington, vol. 40, p. 131.
1931. *Rhagovelia plumbea,* Gould, Kansas Univ. Sci. Bull., vol. 20, p. 39. (records from Florida, Grenada, St. Vincent, Jamacia; gives redescription).
1931. *Rhagovelia salina Gould,* (*nec.* Champion) Kansas Univ. Sci. Bull., vol. 20, p. 41 (describes *R. plumbea* as *R. salina*).
1931. *Rhagovelia plumbea,* Drake and Harris, Pan Pacific Ent., vol. 8, p. 35 (record from Grenada, W. Indies, and Honduras).
1935. *Rhagovelia plumbea,* Drake and Harris, Proc. Biol. Soc. Washington, vol. 48, p. 35 (places specimens described by Gould as *R. salina* as *R. plumbea*).

Size:	*Length*	*Width*
	2.37 mm. apterous male	1.00 mm. apterous male
	3.46 mm. apterous female	1.52 mm. apterous female

Color: General color blue-gray, clothed with golden pubescence. Pronotum broadly orange in center, becoming blue-gray toward lateral margins (on some individuals pronotum is almost all orange with only a trace of blue-gray at sides). Mesonotum on some specimens with faint, narrow, brown line down center. Venter pruinose orange to gray-brown. Base of antennae, margins of all acetabulae, anterior and posterior coxae, all trochanters, basal half of anterior and posterior femora yellow to orange. Margins of connexiva yellow to blue-gray. Legs brown except where otherwise noted.

Structural characteristics: Pronotum sutured off from mesonotum in apterous forms. *Apterous male:* anterior trochanter unarmed. Anterior femora slightly arcuate; anterior tibia arcuate, not dilate, slightly flattened near apex on ventral side. Pronotum wider than long (L. 12, W. 52), and distinctly sinuate along posterior margin. Mesonotum truncate at apex (W. 58, L. 40). Proportions of antennae: Seg. I: II: III: IV:: 51: 26: 34: 26; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 118: 98: 60: 45; of posterior legs: 77: 103: 4: 18. Venter without median carina. Posterior trochanter unarmed. Posterior femur slightly incrassate (L. 75, W. 12) and armed at apical two fifths with one short, inconspicuous spine followed by row of four smaller, subequal spines which ends at approximately apical one fifth. Posterior tibia straight and unarmed. Genital segments small and deeply set into abdomen. *Apterous female:* pronotum formed as in male (L. 14, W. 65). Mesonotum broadly truncate, posterior margin sinuate

(L. 56, W. 84). Proportions of antennae: 66: 35: 44: 30; of intermediate legs: 147: 117: 77: 54; of posterior legs: 88: 125: 4: 26. Connexiva reflexed, widely separated. Abdomen tapers rather evenly to apex. Posterior trochanter unarmed. Posterior femur not incrassate (L. 88, W. 11); unarmed. Posterior tibia straight and unarmed. Genital segments small. *Winged forms:* unknown.

Comparative notes: This species is one of the two brackish or salt-water *Rhagovelia.* It can be separated from *R. salina* (Champion), which is the other species which inhabits salt water, by the proportions of the antennae, and by the lead-gray color of *R. plumbea* Uhler which is unique among the species of this genus.

Data on types: The type series of *R. plumbea* Uhler was collected at Grenada and St. Vincent, B. W. I., May 24. All are apterous specimens. The type specimens are in the British Museum.

Data on distribution: Recorded from Grenada and St. Vincent in the British West Indies, Honduras, Florida, and Jamaica. The following specimens have been examined (new records for major political areas are indicated with an asterisk):

BRITISH HONDURAS: Punta Gorda, Feb. 1931, 2 apterous males, 2 apterous females; Punta Gorda, July, 1934, purchased of Parish, 4 apterous females; Punta Gorda, 1932, J. J. White, 1 apterous male, 3 apterous females.

BRITISH WEST INDIES: Grand Cayman Isl., 6-23-38, Oxford Biol. Ex., Lewis and Thomps., Booby Creek, No. 623385 (exchange from Jamaica Mus.), 4 apterous males, 9 apterous females; Grand Cayman Isl., 6-23-38, Oxford Biol. Exp., Lewis and Thomps., Ford's Creek, No. 623386 (exchange from Jamaica Museum), 8 apterous males, 4 apterous females; Nassau (J. R. de la Torre-Bueno Collection), 1 apterous female; Jamaica (J. R. de la Torre-Bueno Collection), 2 apterous females; Jamaica, Claremont Baron, Hill Trelawny, 12-24-38, L. G. Perkins, 14 apterous males, 91 apterous females, 10 nymphs.

UNITED STATES: *Florida:* Cape Sable, 2-4-31, S. W. Frost, 4 apterous males, 5 apterous females, 3 nymphs; Tortugas, Marquesas Is., Aug. 11, 1931 (Salinity 3.83), A. S. Pearse, 6 apterous males, 6 apterous females, 3 nymphs; Homestead Air Base, XI-23-42, E. D. Hardy, 1 apterous male, 1 apterous female.

* VIRGIN ISLANDS: St. Croix, Christiansted, 1941, N 1 & 2, 5 apterous males, 15 apterous females.

Rhagovelia salina (Champion)

(Pl. III, fig. 14)

1898. *Trochopus salinus* Champion, Biol. Central America, Het., vol. 2, p. 140.
1901. *Rhagovelia salina*, Kirkaldy, Ent., vol. 34, p. 308 (mentions in key).
1923. *Rhagovelia salina*, Torre-Bueno, *In* Connecticut Geo. & Nat. Hist. Surv. Bull., vol. 34, p. 418.
1931. *Rhagovelia salina*, Gould, Kansas Univ. Sci. Bull., vol. 20, p. 41 (describes *R. plumbea* as *R. salina*).

Size:	*Length*	*Width*
	3.50 mm. apterous male	1.40 mm. apterous male
	3.73 mm. apterous female	1.66 mm. apterous female

Color: General color brown-black, clothed with golden pubescence. Pronotum pruinose at sides with central area orange. Mesonotum with pruinose or blue-gray area on each side of median line. Margins of connexiva light brown. Light brown spots on dorsum of last one or two abdominal segments. Venter blue-gray to brown. Venter of last abdominal segment light brown. Base of antennae, all coxae and trochanters light brown. Legs dark brown except anterior femora which are light brown at base.

Structural characteristics: Pronotum sutured off from mesonotum in apterous forms. *Apterous male:* anterior trochanter armed with one long, inwardly directed, black-tipped spine. Anterior tibia slightly arcuate, not dilate, slightly flattened on ventral surface. Pronotum much wider than long (L. 15, W. 75), posterior margin slightly sinuate; mesonotum truncate at apex (L. 51, W. 82). Proportions of antennae: Seg. I: II: III: IV:: 73: 37: 50: 46; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 132: 118: 56: 54; of posterior legs: 100: 122: 5: 33. Abdomen broad, margins of connexiva approximately parallel at first, then converging for last three abdominal segments. Venter without median carina. Posterior trochanter unarmed. Posterior femur moderately incrassate (L. 100, W. 25); armed on basal half with row of three to five subequal, small spines, then, just after middle with one long spine followed by six or seven rapidly decreasing spines to apex. Posterior tibia straight and unarmed. *Apterous female:* Pronotum formed as in male (L. 13, W. 78), mesonotum truncate at apex (L. 52, W. 95). Proportions of antennae: 75: 39: 48: 41; of intermediate legs: 135: 125: 58: 58; of posterior legs: 100: 134: 4: 37. Conneviva broad, not reflexed over abdomen. Posterior trochanter unarmed. Posterior femur moderately incrassate (L. 100, W. 22); armed after middle with one or two very small spines, or may be unarmed. Posterior tibia straight and without a spur at apex. *Winged forms:* unknown.

Comparative notes: This species is a salt- and brackish-water inhabitant as is *R. plumbea* Uhler. *R. salina* (Champion) can be separated from *R. plumbea* Uhler by proportions of the antennae and legs. Also the presence of the long spine on the anterior trochanter of the apterous male of *R. salina* (Champion) will serve to separate these two species.

Data on types: The type specimens are apterous males and females taken in Panama, San Miguel in the Pearl Islands. The type material is in the British Museum.

Data on distribution: Known only from the type locality. The following specimens have been examined:

PANAMA: San Miguel, Pearl Isl., Champion, 1 apterous female; San Miguel, Pearl Isl., Champion, B. C. A. Rhyn. II., *Trochopus salinus* Ch. (J. R. de la Torre-Bueno Collection), 3 apterous males.

Rhagovelia spinosa Gould

(Pl. III, fig. 15)

1931. *Rhagovelia spinosa* Gould, Kansas Univ. Sci. Bull., vol. 20, p. 43.

Size:	*Length*	*Width*
	2.60 mm. apterous male	1.00 mm. apterous male
	3.13 mm. apterous female	1.20 mm. apterous female
	2.85 mm. winged male	1.20 mm. winged male
	3.14 mm. winged female *	1.30 mm. winged female

Color: General color black, clothed with golden pubescence. Pronotum with yellow to yellow-brown band behind vertex of head, becoming pruinose behind eyes. Dorsum of abdomen with median shining areas on last four or five segments which vary in color on different specimens from light yellow-brown to black. Margins of connexiva yellow-brown. Venter blue-gray. Venter of last abdominal segment yellow to light brown beneath. Legs black to brown. Base of antennae, margins of all acetabulae, all coxae and trochanters, and bases of anterior and posterior femora yellow. Occasional specimens have more extensive yellow markings on venter and appendages.

Structural characteristics: Pronotum sutured off from mesonotum in apterous forms. *Apterous male:* anterior trochanter unarmed. Anterior tibia not dilate, slightly excavate on ventral surface. Pronotum much wider than long (L. 13, W. 54); mesonotum truncate at apex (L. 45, W. 58) slightly depressed in center on anterior fifth. Proportions of antennae: Seg. I: II: III: IV:: 50: 27: 29: 27; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 90: 70: 35: 42;

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* Tips of wings broken. The measurement given is total length to apex of abdomen.

of posterior legs: 68: 83: 7: 17. Abdomen tapers gradually to apex, the angle of taper increasing for last three abdominal segments. Venter without ventral carina. Venter bearing stout slightly curved, median spine on anterior edge of last abdominal segment. Posterior trochanter unarmed. Posterior femur slightly incrassate (L. 68, W. 13) and armed just before apical one third with one moderate spine followed by two or three very short spines to apex. Posterior tibia straight and unarmed. *Apterous female:* pronotum formed as in male (L. 12, W. 62); mesonotum as in male (L. 49, W. 76). Proportions of antennae: 55: 31: 33: 27; of intermediate legs: 104: 77: 38: 48; of posterior legs: 77: 92: 9: 18. Connexiva vertical at first, slightly reflexed for last three segments. Venter without spine on last abdominal segment. Posterior trochanter unarmed. Posterior femur slightly incrassate (L. 77, W. 13) and seemingly unarmed. Posterior tibia straight and unarmed. *Winged forms:* Proportions and armature similar to apterous forms. Spine on venter of male same as in apterous form. Pronotum with prominent humeri; rounded at apex.

Comparative notes: This species resembles *R. festae* Kirkaldy, but the proportions of the antennae are not as given for that species. The ventral spine on the last abdominal segment of the male will serve to separate *R. spinosa* Gould from all other species so far discovered in the genus.

Data on types: The holotype is an apterous male, the allotype, an apterous female. Morphotypes are a winged male and a winged female. There is one apterous male paratype. The holotype and paratype labels bear the following data: "Tena, near Oriente, Ecuador, Mar. 29-April 10, 1923, F. X. Williams." The male morphotype label has the following data on collection: "Near Napo, Ecuador, Feb. 14, 1923, F. X. Williams." The allotype and thirteen parallotypes have the following data on collection: "Aguaitia, Dept. Loreto, Peru, S. A., IX-1-46, F. Woytkowski." The female morphotype bears the following data on collection: "Peru, Dept. Huanuco, Vic. of Afilador, shady jungle, 670 m.a.s.l., June 10-30, 1937, F. Woytkowski, No. 3766." All type specimens are in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on distribution: In addition to the type specimens described from Eucador, specimens from the following localities have been examined (new records for major political areas are indicated with an asterisk):

* HONDURAS: Tela, 1923, T. H. Hubbell, 2 apterous males, 1 apterous female.

* PERU: Aguaitia, Dept. de Loreto, IX-19-46, F. Woytkowski, 3 apterous males, 13 apterous females; River Marañon, Vic. of Balsas, Dept. Cajamarca, June 29-36, F. Woytkowski, No. 3634, 2 apterous males, 2 winged males, 1 apterous female, 1 nymph; Dept. Huánuco, Vic. of Afilador, shady jungle, 690 m.a.s.l., June 10-30, 1937, F. Woytkowski, No. 3766, 2 apterous males, 3 winged males, 3 apterous females, 1 winged female (the female morphotype); Aguaitia, Dept. Loreto, IX-1-46, F. Woytkowski, 10 apterous males, 14 apterous females (includes allotype and the 13 parallotypes).

Rhagovelia tantilla Drake and Harris

(Pl. III, fig. 16)

1933. *Rhagovelia tantilla* Drake and Harris, Proc. Biol. Soc. Washington, vol. 46, p. 49.

Size:	*Length*	*Width*
	2.86 mm. apterous male	1.00 mm. apterous male
	3.05 mm. apterous female	1.07 mm. apterous female
	3.32 mm. winged male	1.20 mm. winged male
	3.66 mm. winged female	1.23 mm. winged female

Color: General color black, clothed with brown pubescence. Pronotum with narrow, anterior orange band behind vertex of head becoming pruinose behind the eyes. Dorsum of abdomen with black, shining spots on last one or two segments. Margins of connexiva black. Venter blue-gray, except for last abdominal segment which has black to dark brown ventral area. Base of antennae, all acetabulae, anterior and posterior coxae and trochanters, and basal one third of anterior femora yellow. Intermediate coxae light brown. Genital segments brown. Wings brown.

Structural characteristics: Pronotum sutured off from mesonotum in apterous forms. *Apterous male:* anterior trochanter unarmed. Anterior tibia slightly dilate and only slightly flattened on ventral surface. Pronotum much wider than long (L. 13, W. 57); mesonotum truncate at apex (L. 45, W. 61). Proportions of antennae: Seg. I: II: III: IV:: 47: 25: 28: 30; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 100: 68: 31: 45; of posterior legs: 78: 83: 7: 17. Abdomen tapers slightly until last three segments where angle of taper increases. Connexiva flat. Abdomen tumid beneath; median, ventral carina present on last segment which is depressed slightly to each side. Posterior trochanter unarmed. Posterior femur moderately incrassate (L. 78, W. 15) and armed beyond middle with one long spine followed by five or six smaller, decreasing spines to apex. Posterior tibia straight and unarmed with no evident spur at apex. *Apterous female:* pronotum formed as in male (L. 14, W. 55); mesonotum as in male (L. 40, W. 65). Proportions of antennae: 48: 24: 30: 27; of intermediate legs: 100: 68: 36: 46; of posterior legs: 78: 83: 8: 18. Abdomen tapers evenly to apex. Connexiva vertical for half its width then abruptly rolled outward so as to present a flat surface when viewed from above. Dorsum of abdomen longitudinally depressed for last five segments forming a troughlike depression between connexiva. Posterior trochanter unarmed. Posterior femur not as incrassate as in male (L. 78, W. 12) and armed at apical two-fifths with one long, slender spine followed by six or seven smaller, decreasing teeth to apex. Posterior tibia straight and unarmed. *Winged forms:* Proportions of antennae and legs agree with those for apterous forms. Pronotum formed alike in winged male and winged female (L. 76, W. 82); not continued into spinelike process at apex. Dorsum of abdomen of winged female formed as in apterous female. Armature of posterior femora same as for apterous forms. Wings brown; extending well beyond apex of abdomen.

Comparative notes: This species resembles *R. angustipes* Uhler, but can be distinguished from that form by the armature of the posterior tibia and differences in the male clasper. The females of the two species are quite similar.

Data on types: Holotype, apterous male; allotype, apterous female; paratypes numerous apterous males and females. The apterous types were collected in Punta Gorda, Br. Honduras, Feb., 1932, and are in the personal collection of Dr. C. J. Drake. The holomorphotype is a winged male; the allomorphotype a winged female bearing the following data: "Ft. Clayton, Canal Zone, 1933, Capt. R. F. Edwards." The morphotypes are in the Francis Huntington Snow Entomological Collections, University of Kansas, as are two apterous male and one apterous female paratypes.

Data on distribution: In addition to specimens from type locality of British Honduras specimens of this species from the following localities have been examined (new distribution records for major political areas are indicated with an asterisk):

* CANAL ZONE: Ft. Clayton, 1933, Capt. R. F. Edwards, 1 winged male, 1 apterous female, 4 winged females (morphotype series).

PERU: Vic. Rioja, Dept. San Martia, jungle, 900 m.a.s.l., Sept. 9-Oct. 3, '36, F. Woytkowski, No. 3682, 2 apterous males, 1 apterous female.

Rhagovelia tenuipes Champion

(Pl. III, fig. 17)

1898. *Rhagovelia tenuipes* Champion, Biol. Centr. Amer. Het., vol. 2, p. 137.
1901. *Rhagovelia tenuipes,* Kirkaldy, Ento., vol. 34, p. 308 (mentions in key).
1927. *Rhagovelia tenuipes,* Drake and Harris, Proc Biol. Soc. Washington, vol. 40, p. 131.
1927. *Rhagovelia gregalis* Drake and Harris, Proc. Biol. Soc. Washington, vol. 40, p. 136 (describe from Honduras).
1927. *Rhagovelia regalis* Drake and Harris, Proc. Biol. Soc. Washington, vol. 40, p. 137 (describe from Honduras).
1931. *Rhagovelia gregalis,* Gould, Kansas Univ. Sci. Bull., vol. 20, p. 33 (redescribes).
1931. *Rhagovelia confusa* Gould, Kansas Univ. Sci. Bull., vol. 20, p. 23 (describes from Ecuador).
1931. *Rhagovelia obscura* Gould, Kansas Univ. Sci. Bull., vol. 20, p. 38 (describes from Ecuador).
1931. *Rhagovelia tenuipes,* Gould, Kansas Univ. Sci. Bull., vol. 20, p. 44 (describes from literature).
1931. *Rhagovelia regalis,* Gould, Kansas Univ. Sci. Bull., vol. 20, p. 39 (redescribes).
1935. *Rhagovelia tenuipes,* Drake and Harris, Proc. Biol. Soc. Washington, vol. 48, p. 36 (record from Honduras, Guatemala and Mexico).
1935. *Rhagovelia gregalis,* Drake and Harris, Proc. Biol. Soc. Washington, vol. 48, p. 35 (make corrections to original description and add Guatemala and Perú to distribution record).
1935. *Rhagovelia obscura,* Drake and Harris, Proc. Biol. Soc. Washington, vol. 48, p. 35 (place *R. obscura* as a synonym of *R. gregalis*).
1935. *Rhagovelia regalis,* Drake and Harris, Proc. Biol. Soc. Washington, vol. 48, p. 35 (place *R. confusa* as a synonym of *R. regalis*; give relationship as close to *R. gregalis*).
1944. *Rhagovelia tenuipes,* Hungerford, Zoologica, vol. 29, 3, p. 129 (records from Venezuela).

Size:	*Length*	*Width*
	3.16 mm. apterous male	1.16 mm. apterous male
	3.66 mm. apterous female	1.46 mm. apterous female
	4.18 mm. winged male	1.66 mm. winged male
	4.45 mm. winged female	1.72 mm. winged female

Color: General color black, clothed with fine, brown pubescence. Pronotum with narrow orange band behind vertex of head becoming more or less pruinose behind eyes. Pronotum with faint, darker, longitudinal line down middle. Dorsum of last one to four abdominal segments with black, shining areas, some specimens have black, shining areas on dorsum of all abdominal segments. Margins of connexica black. Base of antennae, anterior and posterior coxae and trochanters yellow to light brown. Venter blue-gray. Venter of last abdominal segment black beneath. Legs brown toward their apices.

Structural characteristics: Pronotum sutured off from mesonotum in apterous forms. *Apterous male:* anterior trochanter unarmed; anterior tibia not dilate, slightly flattened on inner surface for apical half. Pronotum much wider than long (L. 14, W. 73); mesonotum truncate at apex (L. 64, W. 79). Proportions of antennae and legs variable in this species (see discussion under "*Comparative notes*"). Proportions given are of representative specimens in each case. Proportions of antennae: Seg. I: II: III: IV:: 70: 43: 44: 39; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 146: 97: 58: 55; of posterior legs: 114: 108: 11: 21. Abdomen tapers more sharply to apex for last three segments. Venter of abdomen with median carina faintly raised for last three segments, becoming rather strong on last segment where the abdomen is depressed on each side. Posterior trochanter unarmed. Posterior femur extending well beyond apex of abdomen with first spine at approximately the middle of genital segments when femur is held parallel to longitudinal axis of body; most incrassate near base (L. 114, W. 20) and tapering gradually to apex; armed at approximately the middle with one long bent spine followed by ten to twelve smaller, decreasing spines to apex. Posterior tibia straight; armed with subequal teeth along inner surface and definite spur at apex. *Apterous female:* anterior tibia formed as in male. Pronotum formed as in male (L. 14, W. 77). Mesonotum inconspicuously sutured off from metanotum on posterior edge. Proportions of antennae: 66: 38: 43: 36; of intermediate legs: 138: 88: 52: 56; of posterior legs: 107: 105: 14: 23. Connexiva horizontal to vertical but not reflexed. Venter without ventral carina. Posterior trochanter unarmed. Posterior femur projects beyond apex of abdomen, but not to as great an extent as in male; not as incrassate as male (L. 107, W. 16); armed beyond middle with one long, bent spine followed by six or seven smaller decreasing teeth to apex. Posterior tibia straight; armed with small teeth on inner surface and spur at apex. *Winged forms:* proportions and armature much as in apterous forms. Pronotum conspicuously punctate along posterior margin (L. 100, W. 107), not prolonged into spiniform process.

Comparative notes: This species resembles *R. angustipes* Uhler, but can be separated from that species by the nature of the posterior femur in the male, which projects well beyond the apex of the abdomen in *R. tenuipes* Champion. The armature of the posterior femur is also different as is the clasper of the male which is more pointed in *R. tenuipes* Champion. The females of the two species can be separated by the formation of the dorsum of the abdomen.

After careful examination of 227 specimens from 26 localities in Central and South America the author has come to the conclusion that *R. tenuipes* Champion is quite variable in the extent of color markings and proportions of legs and antennae. This variation has led to the proposal of *R. gregalis* Drake and Harris, *R. regalis* Drake and Harris, *R. confusa* Gould and *R. obscura* Gould as synonyms. The variations in proportional measurements have been noted by Gould (1931: p. 24) in his original description of *R. confusa* where he gives a table of measurements and states: "The above proportions are averages from a series of twenty-seven specimens as given below. It can readily be seen that the proportions alone are not good characters and are often misleading, especially in a case where only one or two specimens are to be examined." Gould says that his *R. confusa* is in "the *tenuipes* group and differs from that species in having the intermediate tarsal segments equal." However, in his table of measurements these tarsal segments are shown to be quite variable with proportions of 27: 24,27: 22,26: 24,23: 23,24: 25,20: 22 and 24: 25, etc. In his discussion of *R. oscura*, Gould (1931: p. 38) also notes that "the proportional measurements of the specimens included in this species varied, but the numbers used are the averages." Drake and Harris (1935: p. 35) state that *R. confusa* Gould is the same as *R. regalis* Drake and Harris, and further add that *R. regalis* Drake and Harris is close to *R. gregalis* Drake and Harris "from which it may be separated by the less arched mesonotum and the slightly shorter legs." In the same paper Drake and Harris also state that the names *R. gregalis* Drake and Harris and *R. obscura* Gould apply to the same species. Careful study of *R. obscura* Gould and *R. confusa* Gould indicates that they cannot be separated.

One of the specimens included in *R. confusa* Gould was compared with the type specimens of Champion's *R. tenuipes* by Dr. H. B. Hungerford on his 1928 European trip and found to be of that species. *R. tenuipes* Champion was supposed to have been separable by the longer penultimate tarsal segment of the intermediate leg, and a glance at Gould's comparative measurements for *R. confusa* shows that some of his specimens have this condition, while others have the two segments equal, or the penultimate segment shorter.

It is the opinion of the author that all of the above-mentioned names are synonyms of *R. tenuipes* Champion.

The male clasper of all of these forms is no more variable than one would suppose those of a widely distributed species would be.

The armature and form of the posterior femur and tibia, as well as the ventral carina in the male, appear to be constant characters in *R. tenuipes* Champion.

Data on types: Champion's type material is in the British Museum. The original locality is given as "Mexico Teapa in Tabasco." The type specimens of *R. gregalis* Drake and Harris are in the personal collection of Dr. C. J. Drake and were collected in Honduras. Type material of *R. regalis* Drake and Harris in the Iowa State College Collection and was taken in Honduras. The type specimens of *R. confusa* Gould and *R. obscura* Gould were collected in Ecuador and are in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on distribution: Recorded from Mexico, Ecuador, Honduras, British Honduras, Guatemala and Peru. Specimens from the following localities have been examined (new records for major political areas are indicated with an asterisk):

BRAZIL: State of Pará, Lago Grande, Feb. '39, A. M. Olalla, 5 apterous males, 9 apterous females.

BRITISH WEST INDIES: Trinidad, Port of Spain (J. R. de la Torre-Bueno Collection), 7 apterous males, 6 apterous females; Trinidad, Verdand Vale, on surface of river, 4-26-1931, W. E. Broadway (purchased from W. E. Broadway), 8 apterous males, 21 apterous females; Trinidad, 5-31-1931, W. E. Broadway, 10 apterous males, 2 apterous females.

* COSTA RICA: San Isidro del Gen., 2000 ft., Feb. 1939, Dean L. Rounds, 3 apterous males, 3 winged males, 1 apterous female, 2 winged females.

* COLOMBIA: Villavieja, 1944, R. A. Stirton, 7 apterous males, 7 apterous females.

ECUADOR: Tena, Feb. 23, 1923, F. X. Williams (type material of *R. confusa* Gould in part), 2 apterous males, 2 winged males, 2 apterous females, 1 winged female; Tena, near Orienta, Mar. 29-Apr. 10, 1923, F. X. Williams (type material of *R. confusa* Gould in part), 2 apterous females; Tena, Vic. Oriente, Mar. 29, 1923 (type material *R. confusa* Gould in part), 1 winged male, 2 apterous females; near Napo, Feb. 14, 1928, F. X. Williams (type material *R. confusa* Gould in part), 3 apterous males; Mera, Feb. 3, 1923, F. X. Williams (type material *R. confusa* Gould in part), 1 apterous male, 2 apterous females; Feb. 11-23, F. X. Williams (type material *R. confusa* Gould in part), 4 apterous males, 1 winged male, 1 apterous female; Naranjapata, 1850 ft., Dec. 14, 1923, F. X. Williams (type material of *R. obscura* Gould), 5 apterous males, 3 apterous females; Puyo, Oriente, Nov. 26, 1936, Clarke-McIntyre, 17 apterous males, 16 apterous females, 1 winged female; Mera, 11-14-36, Clarke-McIntyre, 3 apterous males, 3 apterous females; Oriente, E. Río Napo watershed, Jatun Yuca, 700 mtrs. Mar. 1937, Clarke-McIntyre, 16 apterous males, 4 winged males, 20 apterous females, 2 winged females.

Mexico: *Chiapas:* Hda. La Libertad, Sept. 1, 1937, H. D. Thomas, 1 apterous male.

Honduras: Negrito, Mar. 27, 1923, 1412, T. H. Hubbell, 12 apterous males, 23 apterous females.

Peru: Dept. Cajamarca, Andes, R. Lallanga, Vic. Llangua, Mar. 12-14, '36, F. Woytkowski, No. 3642, 6 apterous males, 1 winged female, 6 apterous females; vic. San Pedro, 900 m.a.s.l., jungle pools, May 15-29, 1935, F. Woytkowski, 6 apterous males, 6 apterous females; Dept. Cajamarca, Andes, R. Lallanga, Vic. Llangua, June 20, 1935, F. Woytkowski, No. 3633, 4 winged males, 7 apterous females, 2 winged females; Vic. Sani Beni, 840 m.a.s.l., River Sani Beni, Sept. 5, 1935, F. Woytkowski, No. 3551, 2 apterous males, 1 winged male, 3 apterous females, 5 winged females; Vic. Sani Beni, 840 m.a.s.l., from river, Oct. 9, 1935, F. Woytkowski, No. 3548, 1 winged female; Vic. Rioja, Dept. San Martín, jungle, 900 m.a.s.l., Sept. 9-Oct. 3, 1936, F. Woytkowski, No. 3682, 1 apterous male, 1 apterous female; Dept. Cajamarca, Andes, 1179 m.a.s.l., River Marañon, Vic. of Balsas, June 26-29, 1936, F. Woytkowski, No. 3634, 2 apterous males, 5 apterous females, 1 winged female.

Venezuela: San Esteban, Nov. 22, 1939, Pablo J. Anduze, 5 apterous males, 6 apterous females; Caripito, 20-III, 1942, Wm. Beebe, 2 apterous males, 2 apterous females; Macuto, La Guaiza (J. R. de la Torre-Bueno Collection) 1 apterous male, 2 apterous females; Macuto, La Guazza, Festa (J. R. de la Torre-Bueno Collection), 1 apterous male, 2 apterous females; Puerto Cabello, Sievers Coll. Geo. Ges. ded. 6 X 93 (J. R. de la Torre-Bueno Collection) 3 apterous females.

Rhagovelia velocis Drake and Harris

(Pl. III, fig. 18)

1935. *Rhagovelia velocis* Drake and Harris, Proc. Biol. Soc. Washington, vol. 48, p. 36.

Size:	*Length*	*Width*
	3.13 mm. apterous male	1.20 mm. apterous male
	3.45 mm. apterous female	1.38 mm. apterous female

Color: General color pruinose black, clothed with short yellow, and longer brown hairs. Pronotum with orange band behind vertex of head. Margins of connexiva and spots on dorsum of last one (male) to three (female) abdominal segments shining black. Venter blue-gray clothed with white or gray hair; venter of last abdominal segment and genital segments black. Base of antennae, margins of all acetabulae (more or less), anterior and posterior coxae and trochanters, and basal half of anterior femora yellow to light brown.

Structural characteristics: Pronotum sutured off from mesonotum in apterous forms. Body and legs thickly beset with long brown hair. *Apterous male:* anterior trochanter unarmed. Anterior tibia only slightly dilate; flattened on ventral surface near apex. Pronotum much wider than long (L. 13, W. 67); mesonotum narrowly truncate at apex (L. 56, W. 73). Proportions of antennae: Seg. I: II: III: IV:: 56: 32: 31: 31; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 128: 90: 51: 48; of posterior legs: 95: 97: 12: 22. Abdomen tapers gradually at first; angle of taper increases for last three segments. Venter without median carina. Posterior trochanter unarmed. Posterior femur only slightly incrassate (L. 95, W. 17); armed just beyond middle with one long, curved spine followed by five or six widely spaced, much smaller spines to apex. Posterior tibia straight; armed at apex with straight spur. *Apterous female:* pronotum as in apterous male (L. 15, W. 74); mesonotum more broadly truncate than in male (L. 62, W. 82). Proportions of antennae: 62: 34: 34: 31; of intermediate legs: 140: 93: 48: 55; of posterior legs: 102: 110: 13: 22. Abdomen shaped much as in male. Venter without ventral carina. Posterior trochanter unarmed. Posterior femur not as incrassate as in male (L. 102, W. 14) and armed with one slender, curved spine beyond middle followed by three or four much smaller decreasing spines. Posterior tibia straight; armed at apex with straight spur. *Winged forms:* There are no winged forms of this species in the Francis Huntington Snow Entomological Collections, University of Kansas. The original description describes them as: "Pronotum very large, indistinctly carinate down the middle, strongly convex above, distinctly punctate, the punctures conspicuous on posterior portion; humeri moderately prominent; color similar but the long hairs not as numerous as in apterous form. Hemelytra dark brown, the nervures darker, moderately prominent, clothed with coarse hairs; extending beyond apex of abdomen." Proportions of antennae and legs are similar to those of apterous forms.

Comparative notes: This species resembles *R. versuta* Drake and Harris, from which it can be separated by the entirely black anterior femora of that species. The male clasper also will serve to distinguish these two species as the clasper of the male *R. velocis* Drake and Harris is much more pointed at the apex than that of *R. versuta* Drake and Harris.

Data on types: Holotype, apterous male; allotype, apterous female; morphotype, winged male; and paratypes, male and female. The type series was collected at La Merced, Junín, Peru, Nov. 1933. The type series is in the personal collection of Dr. C. J. Drake. There is one apterous male and one apterous female paratype of this species in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on distribution: In addition to the material from the type locality specimens have been examined from the following localities:

PERU: Aguaitia, Dept. Loreto, IX-1-46, F. Woytkowski, 2 apterous males, 2 apterous females; Aguaitia, Dept. Loreto, IX-19-46, F. Woytkowski, 1 apterous male, 3 apterous females; Roqueron del Padro, Abad Cordulera Azul, Dept. Loreto, 1 apterous female; Río Paucartambo, Bot. 1934 of Gertrude E. Nelson, 1 apterous male; Dept. Ayacucho, Prov. La Mar. Sivia, Jungle, 790 m.a.s.l., jungle brooks, June 24-30, 1941, F. Woytkowski, No. 425, 16 apterous females.

Rhagovelia versuta Drake and Harris

(Pl. III, fig. 19)

1935. *Rhagovelia versuta* Drake and Harris, Proc. Biol. Soc. Washington, vol. 48, p. 37.

Size:	*Length*	*Width*
	3.45 mm. apterous male	1.25 mm. apterous male
	4.13 mm. apterous female	1.60 mm. apterous female
	3.70 mm. winged male	1.60 mm. winged male
	4.06 mm. winged female	1.66 mm. winged female

Color: General color pruinose black, covered with fine golden pubescence and longer brown hair. Pronotum with anterior band orange behind vertex of head, becoming pruinose behind eyes. Dorsum with shiny black spots on last one (male) to three (female) abdominal segments. Connexiva margined with black. Venter blue-gray. Venter of last segment of abdomen with median, ventral, black area. Genital segments black. Base of first segment of antennae, margins of all acetabulae, anterior and posterior coxae light brown to yellow. Wings brown, veins darker and thickly beset with brown hair.

Structural characteristics: Pronotum sutured off from mesonotum in apterous forms. *Apterous male:* anterior trochanter unarmed;

anterior tibia only slightly dilate, flattened on ventral surface. Pronotum much wider than long (L. 17, W. 73); mesonotum truncate at apex (L. 65, W. 81). Proportions of antennae: Seg. I: II: III: IV:: 67: 37: 39: 39; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 145: 107: 55: 58; of posterior legs: 112: 120: 13: 25. Abdomen tapers to apex, angle of taper increasing for last three segments. Venter without median carina. Posterior trochanter unarmed. Posterior femur slightly incrassate (L. 112, W. 22) and armed at approximately middle with one long, curved, black spine followed by approximately ten much smaller, gradually decreasing spines to apex. Posterior tibia straight and armed at apex with a stout spur. *Apterous female:* pronotum formed as in apterous male (L. 18, W. 78); mesonotum much as in apterous male (L. 75, W. 100). Proportions of antennae: 75: 43: 47: 43; of intermediate legs: 160: 120: 58: 63; of posterior legs: 130: 135: 16: 27. Abdomen tapers rather evenly to apex, angle of taper increasing for last three segments. Venter without median carina. Posterior trochanter unarmed. Posterior femur not as incrassate as in male (L. 130, W. 20) and armed at apical two fifths with one long curved spine followed by five or six rapidly decreasing spines to apex. Posterior tibia straight; armed at apex with a stout spur. *Winged forms:* proportions and armature similar to those of apterous forms. Pronotum rounded and beset with long hairs at apex; punctate along posterior portion.

Comparative notes: This species resembles *R. velocis* Drake and Harris, but can be separated from that species by the color of the anterior femur, which is black for its entire length in *R. versuta* Drake and Harris but in *R. velocis* Drake and Harris the basal half is yellow. Also the size differs, as does the shape of the male clasper which is more bluntly rounded than that of *R. velocis* Drake and Harris.

Data on types: Holotype, male; allotype, female; paratypes, several specimens taken with types from Río Paucartambo, Quiroz, Peru, Dec., 1933. The type series is in the personal collection of Dr. C. J. Drake except for an apterous male and an apterous female paratype, which are in the Francis Huntington Snow Entomological Collections of the University of Kansas. The holomorphotype is a winged male, and the allomorphotype, a winged female; both collected at Hermosa, Perú, May 1-5, 1935 by F. Woytkowski. These type specimens are in the Francis Huntington Snow Entomological Collection, University of Kansas.

Data on distribution: Recorded from Perú and Argentina. In addition to the above mentioned paratype specimens, specimens from the following localities have been studied (new records for major political areas are indicated with an asterisk):

* BOLIVIA: Dept. Cochambamba, mte. Tunari, Liriuni, Dec., 1938, A. M. Olalla, 3 apterous males, 8 apterous females.

PERU: Río Paucartambo, Bot. 1934 of Gertrude E. Nelson, 3 apterous males, 9 apterous females; Vic. Pampa Hermosa, 1600 m.a.s.l., stream pools, May 1-5, 1935, F. Woytkowski, 1 apterous female, 1 winged male, 1 winged female; Vic. San Pedro, 900 m.a.s.l., jungle pools, May 15-29, 1935, F. Woytkowski, 2 apterous males, 3 apterous females; Vic. San Pedro, 900 m.a.s.l., River Satipo, May 15-19, 1935, F. Woytkowski, 1 apterous male; Vic. San Pedro, 900 m.a.s.l., ponds and pools, May 15-19, 1935, F. Woytkowski, 1 apterous female.

Rhagovelia paulana Drake

(Pl. III, fig. 20)

1953. *Rhagovelia paulana* Drake, Proc. Biol. Soc. Washington, vol. 66, p. 149.

Size:	*Length*	*Width*
	2.87 mm. apterous male	1.07 mm. apterous male
	3.26 mm. apterous female	1.22 mm. apterous female
	3.60 mm. winged male	1.33 mm. winged male
	3.40 mm. winged female *	1.39 mm. winged female

Color: General color black, somewhat pruinose, clothed with sparse golden pubescence. Pronotum with orange band behind vertex of head, becoming pruinose behind eyes. Margins of connexiva black. Dorsum of last abdominal segment with rectangular, black, shining area. Venter blue-gray. Venter of last abdominal segment black to dark brown beneath. Base of antennae, margins of all acetabulae, anterior and posterior coxae and trochanters, and base of anterior femora yellow. Wings brown, slightly lighter toward apex.

Structural characteristics: Pronotum sutured off from mesonotum in apterous forms. *Apterous male:* anterior trochanter armed beneath at apical one fourth with a stout yellow spine. Anterior tibia slightly dilate and flattened on apical two fifths. Pronotum wider than long (L. 15, W. 67); mesonotum broadly rounded at apex (L. 55, W. 69). Proportions of antennae: Seg. I: II: III: IV:: 50: 33: 31: 30; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 118: 88: 45: 49; of posterior legs: 83: 97: 5: 17. Abdomen tapers rather

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* Tips of wings broken. The measurement given is total length to apex of abdomen.

evenly to apex with slight increase in angle of taper for last three abdominal segments. Venter without median carina; posterior half of venter of last abdominal segment slightly depressed to each side of median tumid area. Posterior trochanter unarmed. Posterior femur only slightly incrassate (L. 83, W. 15); armed just after middle with one long spine followed by eight to ten rapidly decreasing spines to apex. Posterior tibia straight and unarmed. *Apterous female:* anterior trochanter unarmed. Pronotum formed as in male (L. 15, W. 74). Mesonotum (L. 62, W. 88) depressed on posterior half with a depression on each side of middle on posterior quarter; truncate at apex. Proportions of antennae: 46: 31: 31: 29; of intermediate legs: 118: 90: 45: 51; of posterior legs: 83: 100: 7: 18. Dorsum of abdomen with broad carina reaching to the penultimate segment. Connexiva reflexed for last four segments; tumid up to the last segment where it becomes abruptly thinner; diverging at apex. Dorsum of abdomen depressed beneath tumid-reflexed portion of connexiva. Posterior trochanter unarmed. Posterior femur less incrassate than in male (L. 83, W. 11) and armed just before apical one third with one small spine followed by six or seven much smaller, subequal spines to apex. Posterior tibia straight and unarmed. *Winged forms:* pronotum formed alike in both male and female (L. 88, W. 92), slightly depressed on posterior one third. Winged male with anterior trochanter armed as apterous male. Winged female with connexivum not reflexed, but otherwise formed as in apterous female; dorsum of abdomen not sunken, not carinate. Proportions and armature same as apterous forms.

Comparative notes: This species most nearly resembles *R. callida* Drake and Harris. *R. paulana* Drake can be separated from *R. callida* Drake and Harris by the presence of the spur on the anterior trochanter of the male, the lack of the prominent ventral carina of the male, and by the peculiar formation of the connexiva in the female. The only other species of *Rhagovelia,* in the group with the sutured off pronotum, which has an armed anterior trochanter in the male is *R. salina* (Champion) which is an inhabitant of salt- and brackish-water. *R. paulana* Drake can be separated at once from *R. salina* (Champion) by the black intermediate coxae and trochanters and by the much less incrassate posterior femur. The connexiva of the females also are formed differently.

Data on types: Holotype, apterous female, allotype, apterous male, paratypes, many winged and apterous specimens. The type series was collected at Campinas, San Paulo, Brazil, Oct., 1938,

C. J. Drake. The type specimens are in the personal collection of Dr. C. J. Drake. Apterous and winged paratypes are also in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on Distribution: In addition to the paratypes mentioned above, specimens from the following localities have been examined:

Brazil: Nova Teutonia, 27-11, La. 52-23 Lo., XII, 1946, Fritz Plaumann, 7 apterous males, 3 winged males, 8 apterous females, 4 winged females; Nova Teutonia, 27-11 La. 52-23 Lo. XII, 1948, Fritz Plaumann, 26 apterous males, 1 winged male, 48 apterous females, 1 winged female.

Rhagovelia viriosa sp. nov.

(Pl. III, fig. 21)

Size:	*Length*	*Width*
	4.20 mm. apterous male	1.46 mm. apterous male
	4.45 mm. apterous female	1.60 mm. apterous female

Color: General color black, clothed with thick, yellow pubescence and longer brown hairs. Pronotum with orange band on anterior half behind vertex of head, becoming pruinose behind the eyes. Dorsum of last abdominal segment with shining black spot. Margins of connexiva black. Venter blue-gray; venter of last abdominal segment black beneath. Base of antennae, margins of all acetabulae, anterior and posterior coxae yellow. Anterior trochanters and base of femora, intermediate coxae, and posterior trochanters light to dark brown.

Structural characteristics: Pronotum sutured off from mesonotum in apterous forms. *Apterous male:* anterior trochanter unarmed; anterior tibia slightly dilate and flattened beneath. Pronotum much wider than long (L. 17, W. 84); mesonotum broadly rounded at apex (L. 70, W. 87). Proportions of antennae: Seg. I: II: III: IV:: 80: 46: 47: 45; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 152: 118: 55: 62; of posterior legs: 125: 143: 17: 27. Abdomen tapers rather evenly to apex, angle of taper slightly increased on last three segments. Anterior segments of venter of abdomen with no trace of ventral carina. Last three segments of venter of abdomen with prominent median carina with abdomen depressed on each side; abdomen increasingly less tumid for last three segments. Posterior trochanter unarmed. Posterior femur moderately incrassate (L. 125, W. 22) and armed just after apical two fifths with one moderate spine followed by four or five smaller, decreasing spines to apex. Posterior tibia straight and armed on basal two thirds with evenly spaced denticulations, also armed with spur at apex. *Apterous female:* pronotum formed as in male; mesonotum truncate at apex (L. 70, W. 93). Proportions of antennae: 83: 47: 48: 45; of intermediate legs: 157: 125: 60: 63; of posterior legs: 127: 148: 17: 27. Dorsum of abdomen depressed after first segment. Abdomen tapers evenly to apex. Connexiva taper evenly to last segment, last segment of connexiva diverging. Venter of abdomen without median carina. Posterior trochanter unarmed. Posterior femur not as incrassate as that of male (L. 127, W. 20) and armed after apical two fifths with one moderate spine followed by two or three inconspicuous, much smaller spines. Posterior tibia straight and armed only with small spur at apex. *Winged forms:* unknown.

Comparative notes: This species is close to *R. callida* Drake and Harris. *R. viriosa* sp. nov. can be distinguished from *R. callida* Drake and Harris by the shorter posterior femur which extends only to the apex of the genital segments when held parallel to the longitudinal axis of the body, while the posterior femur of *R. callida* Drake and Harris extends well beyond the apex of the genital segments. The female can be recognized by the concave dorsum of the abdomen of *R. viriosa* sp. nov.

Data on types: Holotype, apterous male; allotype, apterous female; paratypes, three apterous males, two apterous females. The data on collection is as follows: "Perú, S. A., VIII, 8, 1936, F. Woytkowski, clear mt. brook." All type specimens are in the Francis Huntington Snow Entomological Collections of the University of Kansas.

Data on distribution: In addition to the type series specimens from the following locality have been studied:

PERU: Vic. Guayabamba, VIII, 12, '36, F. Woytkowski, No. 432, 1 apterous male, 1 apterous female.

Rhagovelia janeira Drake

(Pl. III, fig. 22)

1953. *Rhagovelia janeira* Drake, Proc. Biol. Soc. Washington, vol. 66, p. 151.

Size:	*Length*	*Width*
	3.20 mm. apterous male	1.33 mm. apterous male
	3.66 mm. apterous female	1.67 mm. apterous female
	3.92 mm. winged male	1.73 mm. winged male
	4.13 mm. winged female	1.80 mm. winged female

Color: General color black, clothed with golden pubescence. Anterior half of pronotum with interrupted orange band behind vertex of head, becoming pruinose behind eyes. Mesonotum with darker, longitudinal band more or less distinct. Dorsum of last two or three abdominal segments with black, shining median areas. Margins of connexiva black. Venter blue-gray. Venter of last abdominal segment dark brown to black beneath. Base of antennae, margins of all acetabulae, all coxae, anterior and posterior trochanters, and basal half of anterior femora yellow. Intermediate trochanter light to dark brown. Wings brown.

Structural characteristics: Pronotum sutured off from mesonotum in apterous forms. *Apterous male:* anterior trochanter unarmed; anterior tibia slightly arcuate and flattened beneath on apical one third. Pronotum much wider than long (L. 16, W. 74). Mesonotum truncate at apex (L. 58, W. 79). Proportions of antennae: Seg. I: II: III: IV:: 71: 42: 44: 35; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 135: 92: 48: 58; of posterior legs: 100: 106: 11: 27. Abdomen tapers evenly to apex at first, angle of taper increasing for last two segments. Abdomen without a ventral carina. Posterior trochanter unarmed. Posterior femur only moderately incrassate (L. 100, W. 20) and armed at apical two fifths with one long spine followed by four or five smaller, rapidly decreasing spines to apex. Posterior tibia straight and armed only with small spur at apex. *Apterous female:* pronotum formed as in apterous male (L. 17, W. 83); mesonotum with inconspicuous suture at apex (L. 71, W. 106). Proportions of antennae: 65: 38: 41: 32; of intermediate legs: 138: 98: 48: 60; of posterior legs: 100: 114: 10: 25. Sutures between metanotum and first abdominal segment, and between first four abdominal segments deeply punctate. Abdomen tapers evenly to apex. Connexiva reflexed and meeting on last segment, exposing a triangular portion of dorsum of abdomen. Metanotum produced behind forcing dorsum of first abdominal segment triangularly backward in middle. Venter without carina. Posterior trochanter unarmed. Posterior femur not as incrassate as in male (L. 100, W. 16), flattened on ventral surface, and unarmed. Posterior tibia straight, armed only with inconspicuous spur at apex. *Winged forms:* proportions and armature same as for apterous forms. Connexiva of female not reflexed. Apex of pronotum rounded in both male and female. Costal margin of wing thickly beset for over half its length with long, brown hairs. First longitudinal vein with shorter brown hairs for basal one fifth. Tips of wings extend well over apex of abdomen.

Comparative notes: This species resembles *R. hambletoni* Drake and Harris. *R. janeira* Drake can be separated from *R. hambletoni* Drake and Harris by the clasper of the male which is much more elongate and rounded at the apex whereas the clasper of the male of *R. hambletoni* Drake and Harris is truncate at the apex. The females can be separated by the lack of armature on the posterior femur of *R. janeira* Drake.

Data on types: Holotype, apterous male; allotype, apterous female; paratypes, thirty-eight apterous; four winged specimens. Data on collection is as follows: "Bello Horizonte, Braz., Oscar Monte."; "three specimens, Rio de Janeiro, Braz., Nov., 1938, C. J. Drake; 3 specimens, Rio de Janeiro, Braz., Nov. 10, 1938, Fritz Plaumann." The type specimens are in the personal collection of Dr. C. J. Drake. Paratype specimens are also in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on distribution: In addition to the above mentioned paratype specimens, specimens have been studied from the following locality:

BRAZIL: Nova Teutonia, 27-11 La. 52-23, Lo., XII, 1946, Fritz Plaumann, 22 apterous males, 3 winged males, 21 apterous females, 3 winged females; Nova Teutonia, 1-8-49, 27-11 B. 52-23 L., Fritz Plaumann, 1 apterous male, 8 apterous females, 1 winged female.

ABRUPTA GROUP

Group characteristics: The *abrupta* group can be characterized as consisting of those species of the genus *Rhagovelia* in which the pronotum of the apterous forms is much less than three times as long as the exposed portion of the mesonotum. The dorsum of the abdomen of the apterous female tapers rather evenly to the apex. Winged forms are rather rare; the wings extend well beyond the apex of the genital segments.

The following species comprise this group:

1. *R. abrupta* Gould
2. *R. itatiaiana* Drake *
3. *R. lucida* Gould
4. *R. mira* Drake and Harris
5. *R. torquata* Bacon
6. *R. trepida* Bacon
7. *R. triangula* Drake *
8. *R. trista* Gould
9. *R. vivata* Bacon

KEY TO SPECIES OF THE ABRUPTA GROUP

1. Pronotum definitely shorter than exposed portion of mesonotum.... 2
Pronotum subequal to or longer than exposed portion of mesonotum, 3
2.(1) Posterior trochanter of male armed with several dark teeth..*vivata*
Posterior trochanter unarmed in male..................*torquata*

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* See addenda at end of section on taxonomy for the description of this species which was published after the body of this paper was written.

3.(1) Mesonotum definitely more than ⅔ the length of pronotum 4
Mesonotum approximately or less than ⅔ the length of pronotum .. 6
4.(3) Anterior margin of pronotum dark brown; mesonotum yellow; length of apterous male 4.6 mm. .... *mira*
Anterior margin of pronotum yellow; mesonotum brown; length of apterous male less than 4.5 mm. 5
5.(4) Claspers of male projecting posteriorly beyond terminal genital segment; posterior trochanter of male armed with numerous dark teeth .... *abrupta*
Claspers of male not visible when viewed from above; posterior trochanter of male unarmed .... *torquata*
6.(3) Posterior margin of pronotum yellow; posterior tibia of apterous male usually with enlarged tooth at apical ¼ .... *trepida*
Posterior margin of pronotum same color as disc of pronotum; posterior tibia of apterious male usually without enlarged tooth at apical ¼ 7
7.(6) Third antennal segment of male flattened and dilate, wider than second .... *lucida*
Third antennal segment of male no larger in diameter than second, *trista*

Rhagovelia abrupta Gould

(Pl. IV, fig. 1)

1933. *Rhagovelia hungerfordi* Gould, Ann. Ent. Soc. America, vol. 26, p. 467.
1934. *Rhagovelia abrupta* Gould, Bull. Brooklyn Ent. Soc., vol. 29, p. 56 (changes name of *R. hungerfordi* to *R. abrupta*).

Size:	*Length*	*Width*
	4.00 mm. apterous male	1.40 mm. apterous male
	4.25 mm. apterous female	1.47 mm. apterous female
	4.80 mm. winged male	1.62 mm. winged male
	4.80 mm. winged female	1.66 mm. winged female

Color: General color brown-black, clothed with golden pubescence. Pronotum with narrow, apical, yellow band behind vertex of head, becoming pruinose behind eyes. Dorsum of last one or two abdominal segments with darker shining areas. Venter blue-black. Venter of last abdominal segment shining black beneath. Basal one half of first segment of antennae, all coxae, anterior and posterior trochanters, and basal one half of anterior femora yellow. Intermediate trochanter yellow for basal half, brown to black for apical half. Wings brown, veins only slightly darker.

Structural characteristics: Pronotum in apterous forms abbreviated, rounded behind, and exposing much of mesonotum. *Apterous male:* anterior trochanter unarmed; anterior tibia not dilate, slightly excavate within for apical one sixth. Pronotum short (L. 39, W. 76); mesonotum truncate at apex (L. 35, W. 78); metanotum short (L. 11, W. 85). Proportions of antennae: Seg. I: II: III: IV:: 70:

40: 38: 40; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 140: 105: 48: 58; of posterior legs: 125: 114: 10: 26. Abdomen tapers rather evenly to apex, angle of taper increasing for last three segments. Claspers prominent, curved along each side of genital capsule to project posteriorly beyond apex of genital segments. Venter without median carina. Venter of last abdominal segment with slight median depression forming indistinct longitudinal trough. Posterior trochanter armed with from five to eight small dark teeth. Posterior femur strongly incrassate (L. 125, W. 40). Armed on basal one third with an irregular group of small, black teeth; armed at basal one third with one long spine followed by eight or nine smaller, very gradually decreasing spines to apex; also armed with anterior row of small subequal teeth beginning at basal one third to apex. Posterior tibia slightly arcuate; armed within with two rows of black, subequal teeth; armed with stout spur at apex. *Apterous female:* pronotum rounded behind (L. 42, W. 77); mesonotum truncate at apex (L. 35, W. 73); metanotum short on midline (L. 11, W. 92). Proportions of antennae: 63: 38: 38: 38; of intermediate legs: 133: 100: 45: 57; of posterior legs: 110: 105: 8: 24. Abdomen tapers evenly to apex. Venter without median carina. Posterior trochanter unarmed. Posterior femur moderately incrassate (L. 110, W. 24) and armed after basal one third with one long spine followed by five, smaller, subequal spines and two or three very small spines just before apex. There are also several small inconspicuous teeth on basal one third of posterior femur. Posterior tibia straight; armed with two rows of small teeth and spur at apex. *Winged forms:* proportions and armature similar to apterous forms. Pronotum formed similarly in male and female; rounded behind, deeply punctate on posterior half, and slightly wider than long (L. 105, W. 112). Claspers project beyond apex of terminal genital segment as in apterous male. Wings project beyond apex of genital segments.

Comparative notes: This species resembles *R. torquata* Bacon. The males of *R. abrupta* Gould can be separated from those of *R. torquata* Bacon by the claspers projecting well beyond apex of the genital capsule, and by the teeth on the posterior trochanter.

Data on types: Holotype, apterous male; allotype, apterous female; paratypes, forty-four apterous males, twenty-two apterous females. These specimens were collected as La Salud, Peru, by Juan D. Rivas. The holomorphotype is a winged male and the allomorphotype a winged female collected in the Dept. Huánuco, Carpish, on June 12, 1946, by F. Woytkowski. All of the above mentioned specimens are in the Francis Huntington Snow Entomological Collections, University of Kansas. Paratype specimens also are in the personal collection of Dr. Gould, and in the collections of Purdue University.

Data on distribution: Recorded only from Perú. In addition to the type material, specimens have been examined from the following localities:

PERU: La Salud, Juan De D. Rivas S., 8 apterous males, 5 apterous females; Dept. Huánuco, Carpish, June 12, 1946, F. Woytkowski, 8 apterous males, 10 apterous females, 2 winged females; Río Paucartambo, Bot. 1934 of Gertrude E. Nelson, 3 apterous males, 3 apterous females; Vic. Pampa Hermosa, 1600 m.a.s.l., stream pools, May 1-5, 1935, F. Woytkowski, 3 apterous males, 2 apterous females.

Rhagovelia lucida Gould

(Pl. IV, fig. 2)

1931. *Rhagovelia lucida* Gould, Kansas Univ. Sci. Bull., vol. 20, p. 36.

Size:	*Length*	*Width*
	3.60 mm. apterous male	1.33 mm. apterous male
	3.60 mm. apterous female	1.46 mm. apterous female

Color: General color brown-black; clothed with golden pubescence. Pronotum with anterior yellow band behind vertex of head becoming pruinose behind eyes. Dorsum of last abdominal segment with median, rectangular, shining, brown-black area. Venter blue-gray. Venter of last abdominal segment shining brown-black beneath. Base of antennae, all coxae, anterior and posterior trochanters, basal one half of anterior femora, and basal one fourth of posterior femora yellow.

Structural characteristics: Pronotum abbreviated in apterous forms, rounded behind, and exposing much of mesonotum, *Apterous male:* anterior trochanter unarmed; anterior tibia not dilate, slightly arcuate, and flattened within for apical one half. Pronotum short and rounded behind (L. 44, W. 75); mesonotum broadly truncate at apex (L. 24, W. 81); metanotum not surrounding all of mesonotum at sides (L. 7, W. 87). Third segment of antennae dilate and slightly flattened, wider than second. Proportions of antennae: Seg. I: II: III: IV:: 58: 29: 43: 36; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 123: 100: 47: 53; of posterior legs: 100: 97: 11: 24. Abdomen broad; tapers very slightly at first, angle of taper increasing for last two segments. Venter without median carina. Posterior trochanter armed with numerous very small teeth. Posterior femur strongly incrassate (L. 100, W. 31); armed on basal one half with one row of numerous short spines; armed just before middle with one moderate spine followed by approximately five smaller, gradually decreasing spines to apex. Posterior tibia straight; armed with one row of black teeth along entire surface; armed with slender spur at apex. Apterous female: pronotum formed as in male (L. 47, W. 85); mesonotum truncate at apex (L. 22, W. 93); metanotum formed as in male (L. 13, W. 97). Third antennal segment not dilate. Proportions of antennae: 58: 29: 44: 37; of intermediate legs: 124: 100: 49: 56; of posterior legs: 100: 111: 11: 24. Dorsum of abdomen elevated on median line forming a broad, longitudinal ridge with segments depressed on each side. Connexiva vertical. Genital segments slope downward at angle of forty-five degrees. Posterior trochanter unarmed. Posterior femur much less incrassate than that of male (L. 100, W. 18) and armed just before apical one fourth with one small spine followed by approximately three gradually decreasing spines to apex. *Winged forms:* unknown.

Comparative notes: This species resembles *R. trista* Gould. *R. lucida* Gould can be separated from *R. trista* Gould by the proportions of the antennae, and the armature of the posterior femur. In addition the male of *R. lucida* Gould has an expanded and somewhat flattened third antennal segment, and the posterior trochanter is armed with numerous short teeth. I have before me a series of ten males and nine females of this species and am describing the female allotype to complete the description of this species. The male clasper varies somewhat in some specimens, being more gradually curved near the base; however, the hook at the apex is constant. In Gould's original drawing (1931; p. 57) the clasper is shown without the apex being curved into a hook; however, remounting the same clasper from which his drawing was made, with the clasper lying flat, shows the presence of the hooklike apex.

Data on types: The holotype is an apterous male bearing the following data: "Theresopolis, Rio de Janeiro, Brazil, 8-IX-1923, G. L. R. Hancock." The allotype is an apterous female, as are eight parallotypes, all bearing the following data: "Brazil, S. A., Lagoa dos Quadros, R. G. do Sul., 11-17-41, H. Kleerekoper." The holotype is in the British Museum, and also a parallotype. The allotype and other parallotype specimens are in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on distribution: Recorded only from Brazil. In addition to the locality of the holotype, specimens have been examined from the following locality:

BRAZIL: Lagoa dos Quadros, R. G. do Sul., 11-17-41, H. Kleerekoper, 10 apterous males, 9 apterous females.

Rhagovelia mira Drake and Harris

(Pl. VIII, fig. 3)

1938. *Rhagovelia mira* Drake and Harris, Pan Pacific Ent., vol. 14, p. 152.

Size:	*Length*	*Width*
	4.70 mm. apterous male	1.70 mm. apterous male

Color: General color brown; clothed with a golden pubescence. Pronotum with narrow brown margin behind vertex of head, then a yellow band on anterior one half. Mesonotum yellow with faint brown margin. Connexiva yellow with brown margin along top and on posterior edge of each segment. Dorsum of abdomen with last three to five segments with median yellow spots. Venter yellow except for indistinct brown band along each side. Upper parts of all legs brown, yellow beneath.

Structural characteristics: Pronotum abbreviated, rounded behind, and exposing much of mesonotum. *Apterous male:* anterior trochanter unarmed; anterior tibia not dilate, slightly arcuate, and flattened within for apical one half. Pronotum short and rounded behind (L. 44, W. 93); mesonotum broadly truncate at apex (L. 36, W. 91); metanotum subequal in exposed width at sides and rear (L. 11, W. 110). Proportions of antennae: Seg. I: II: III: IV:: 90: 43: —: —; of intermediate legs: Fem.: Tib.: Tars II: Tars. III:: 182: 147: 51: 64; of posterior legs: 181: 172: 11: 36. Abdomen broad, tapering slightly for first two segments then almost straight. Venter without median carina. Posterior trochanter armed with several small, brown teeth. Posterior femur strongly incrassate (L. 181, W. 70); armed on basal one third with one row of knob-like teeth followed by an anterior row of increasing spines terminating at the apical one fourth with a large, black-tipped spine, and a posterior row of six subequal spines with the last two spines displaced toward the posterior margin of the leg. In addition to these two rows of spines there are three decreasing spines on the median ventral line at the apex of the femur. Posterior tibia strongly arcuate on basal three fourths and then recurving outward at apical one fourth. Armed within with closely set teeth to apical one fourth where one large spine is then followed by several decreasing spines to apex. *Apterous female:* unknown. *Winged forms:* unknown.

Comparative notes: This species resembles no other member of the *abrupta* group yet described. The yellow mesonotum, the greatly incrassate hind femora and the recurved hind tibia will separate it at once from any other member of the group. It is, perhaps, most closely related to *R. torquata* Bacon but can be separated at once by the characters mentioned above.

Data on types: Holotype, apterous male; paratypes, two apterous males. These specimens were collected in "Sierra Maestra, Cuba, July 10-20, 1922, 3000-4250 ft., collected by C. H. Ballou and S. C. Bruner." The holotype and one paratype are in the personal collection of Dr. C. J. Drake, and one paratype is in the Francis Huntington Snow Entomological Collection, University of Kansas.

Data on distribution: Known only from the type series.

Rhagovelia torquata Bacon

(Pl. IV, fig. 3)

1948. *Rhagovelia torquata* Bacon, Jour. Kansas Ent. Soc., vol. 21, No. 3, p. 83.

Size:	*Length*	*Width*
	3.40 mm. apterous male	1.33 mm. apterous male
	3.84 mm. apterous female	1.37 mm. apterous female

Color: General color black, covered with golden pubescence. Pronotum with yellow band on anterior one fourth behind vertex of head, becoming pruinose behind eyes. Venter dark gray. Base of first segment of antennae, all coxae, anterior and posterior trochanters and basal half of anterior femora yellow.

Structural characteristics: Pronotum in apterous forms abbreviated, rounded behind, and exposing much of mesonotum. *Apterous male:* anterior trochanter unarmed; anterior tibia only slightly dilate and not excavate. Pronotum short (L. 32, W. 72); mesonotum longer than pronotum and truncate at apex (L. 35, W. 66); mesonotum surrounded laterally by metanotum (L. 8, W. 82). Proportions of antennae: Seg. I: II: III: IV:: 66: 42: 39: 40; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 148: 105: 46: 57; of posterior legs: 130: 107: 7: 20. Abdomen tapers to apex, angle of taper increasing for last three segments. Posterior trochanter unarmed. Posterior femur moderately incrassate (L. 130, W. 33) and armed on basal one third with one row of several small spines; just after basal one third with one long, black spine followed by seven shorter, gradually decreasing spines to apex. Posterior tibia slightly arcuate and armed on basal two thirds with two rows of closely-set, subequal teeth, on apical third with smaller, widely spaced teeth; armed at apex with stout spur. Posterior femur extends well beyond apex of abdomen. *Apterous female:* anterior tibia formed as in apterous male. Pronotum slightly longer than in male (L. 40, W. 75); mesonotum truncate (L. 30, W. 80); metanotum formed as in male (L. 8, W. 83). Proportions of antennae: 65: 38: 37: 37; of intermediate legs: 185: 95: 43: 54; of posterior legs: 115: 95: 7: 20. Abdomen tapers as in male. Posterior trochanter unarmed. Posterior femur not as incrassate as in male (L. 115, W. 25) and armed before middle with one long spine followed by five to seven smaller, decreasing spines to apex. Posterior tibia armed on basal half with two rows of closely set teeth, seemingly unarmed on apical half except for stout spur at apex. *Winged forms:* unknown.

Comparative notes: This species resembles *R. abrupta* Gould. *R. torquata* Bacon can be separated from *R. abrupta* Gould by the claspers of the male which do not visibly project beyond the terminal genital segments when viewed from above. It also resembles *R. vivata* Bacon but can be separated by the lack of teeth on the posterior trochanter of the male of *R. torquata* Bacon. The male clasper is distinct and readily separates it from either of the above-mentioned forms.

Data on types: Holotype, apterous male; allotype, apterous female; paratypes, one apterous male, one apterous female. Described from series labeled: "Perú, S. A., Dept. Huánuco Vic. of Afilador, shady jungle, 670 m. a. s. l., June 10-30, 1937, F. Woytkowski. No. 3766." All type specimens are in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on distribution: Recorded only from Peru. In addition to the type series, specimens have been examined from the following localities:

PERU: Dept. Huánuco, Vic. Afilador, jungle brooks, 800 m.a.s.l., June 4, 1937, F. Woytkowski, No. 3771, 3 apterous males, 1 apterous female; Dept. Huánuco, Vic. Afilador, jungle brooks, 800 m.a.s.l., June 8-9, 1937, F. Woytkowski, No. 3767, 1 apterous male; Dept. Loreto, Aquaitia, IX-1-46, F. Woytkowski, 2 apterous males, 4 apterous females.

Rhagovelia trepida Bacon

(Pl. IV, fig. 4)

1948. *Rhagovelia trepida* Bacon, Jour. Kansas Ent. Soc., vol. 21, no. 3, p. 84.

Size:	*Length*	*Width*
	3.72 mm. apterous male	1.33 mm. apterous male
	3.78 mm. apterous female	1.33 mm. apterous female

Color: General color brown, covered with golden pubescence. Pronotum with anterior half, and lateral and posterior margins yellow. Margins of connexiva broadly yellow. Venter blue-gray. Venter of last abdominal segment with exception of narrow median line, and genital segments yellow. Base of antennae, all trochanters, all coxae, bases of anterior and posterior femora yellow. Posterior femora yellow, with exception of prominent brown stripe on dorso-posterior surface.

Structural characteristics: Pronotum in apterous forms abbreviated, rounded behind and exposing much of mesonotum. *Apterous male:* anterior trochanter unarmed; anterior tibia not dilate, and only slightly excavate on apical half. Pronotum abbreviated (L. 33, W. 70), exposing much of mesonotum; mesonotum truncate (L. 26, W. 73) and not covering metanotum. Metanotum very short (L. 6, W. 85). Proportions of antennae: Seg. I: II: III: IV:: 57: 30: 37: 34; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 123: 96: 40: 50; of posterior legs: 106: 88: 7: 20. Angle of taper of abdomen increases on last three segments. Slight median ventral carina extends complete length of abdomen. Posterior trochanter unarmed. Posterior femur greatly incrassate (L. 106, W. 38) and armed on basal half with one row of small spines followed at approximately the middle with one larger spine and approximately nine smaller, closely-set spines to apex. Also armed with one short, anterior row of small teeth running from apical one third to apex. Posterior tibia slightly arcuate and armed with closely-set teeth throughout, usually with tooth at approximately apical one fifth enlarged into small spur; also armed with spur at apex. *Apterous female:* pronotum formed as in male (L. 37, W. 80), mesonotum as in male (L. 27, W. 85); metanotum as in male (L. 7, W. 90). Proportions of antennae: 55: 34: 39: 34; of intermediate legs: 123: 95: 39: 52; of posterior legs: 98: 95: 9: 23. Abdomen tapers to apex. Venter without median carina. Posterior trochanter unarmed. Posterior femur not as incrassate as in male (L. 98, W. 21) and armed on basal half with one small tooth or may be unarmed on basal half; apical half armed with one long spine just beyond middle followed by three to five smaller, rapidly decreasing spines to apex. Posterior tibia straight and seemingly unarmed except for small spur at apex. *Winged forms:* unknown.

Comparative notes: This species belongs in the group of *Rhagovelia* with *R. abrupta* Gould because of its pronotal proportions. The armature of the posterior femur, and the distinctive male clasper will serve to separate it from *R. abrupta* Gould.

Data on types: Holotype, apterous male; allotype, apterous female; paratypes, thirty-six apterous males, twenty-three apterous females. Described from specimens labeled: "Sao Paulo, Brazil, XI-17-1935, Nat. Sci. Mus. Via A. M. Olalla." All type specimens are in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on distribution: Known only from type series.

Rhagovelia trista Gould

(Pl. IV, fig. 5)

1931. *Rhagovelia trista* Gould, Kansas Univ. Sci. Bull., vol. 20, p. 45.

Size:	*Length*	*Width*
	3.30 mm. apterous male	1.20 mm. apterous male
	3.65 mm. apterous female	1.23 mm. apterous female
	4.20 mm. winged male	1.33 mm. winged male
	4.25 mm. winged female	1.46 mm. winged female

Color: General color brown-black to black, clothed with brown pubescence. Pronotum with anterior yellow band behind vertex of head, becoming pruinose behind eyes. Median spot on dorsum of last one or two abdominal segments shining black. Venter blue-gray to gray-black. Venter of last abdominal segment black beneath. Base of antennae, all coxae, anterior and posterior trochanters in part, and base of anterior femora yellow. Wings brown.

Structural characteristics: Pronotum abbreviated and rounded behind in apterous forms, exposing much of mesonotum. *Apterous male:* anterior trochanter unarmed; anterior tibia straight, not dilate, and flattened on inner surface for apical one half. Pronotum short, rounded behind (L. 41, W. 67); mesonotum broadly truncate at apex (L. 20, W. 64); metanotum short, surrounding mesonotum at sides (L. 8, W. 82). Proportions of antennae: Seg. I: II: III: IV:: 56: 36: 37: 36; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 125: 90: 40: 51; of posterior legs: 104: 82: 5: 20. Abdomen tapers rather evenly to apex, angle of taper increasing for last three segments. Venter without median carina. Posterior trochanter unarmed. Posterior femur moderately incrassate (L. 104, W. 23); armed just before middle with one long spine, followed by approximately four smaller, subequal spines and three or four very small, rapidly decreasing spines to apex. Posterior tibia slightly arcuate; armed with two rows of closely-set teeth throughout, and curved spur at apex. *Apterous female:* pronotum formed as in male (L. 45, W. 70); mesonotum as in male (L. 24, W. 65); metanotum as in male (L. 8, W. 82). Proportions of antennae: 62: 35: 38: 35; of intermediate legs: 130: 100: 45: 55; of posterior legs: 105: 87: 61: 21. Abdomen tapers evenly to apex. Posterior trochanter unarmed. Posterior femur slightly incrassate (L. 105, W. 21); armed just before middle with one long spine followed by three or four moderate, gradually decreasing spines, and two or three much smaller spines to apex. Posterior tibia formed and armed as in male. *Winged forms:* proportions and armature much as in apterous forms. Pronotum (L. 88, W. 95) deeply and evenly punctate posterior to the anterior yellow band; rounded at apex in both sexes. Wings extend well beyond apex of abdomen.

Comparative notes: This species resembles *R. lucida* Gould. *R. trista* Gould can be separated from *R. lucida* Gould by the armature of the posterior femora. The male of *R. trista* Gould has the posterior trochanter unarmed, and the third antennal segment is subequal to the second in shape and diameter. The claspers of the male are also quite distinctive.

Data on types: Holotype, apterous male; allotype, apterous female; paratypes, one apterous male, twelve apterous females. These specimens were collected in Ecuador, near Mera and Banos in Feb. 1923. Holomorphotype, winged male; allomorphotype, winged female. These specimens were also collected in Ecuador, near Puyo, Oriente, Nov. 26, 1936, by Clarke-MacIntyre. All of the type specimens are in the Francis Huntington Snow Entomological Collection, University of Kansas.

Data on distribution: Recorded only from Ecuador. In addition to the type material specimens have been examined from the following localities (new records for major political areas are indicated with an asterisk):

ECUADOR: Feb. 11, 1923, F. X. Williams, 1 apterous male; Oct. 1935, Wm. MacIntyre, 4 apterous males, 4 apterous females; Nov. 1935, Wm. MacIntyre, 19 apterous males, 17 apterous females; Mera, 11-14-36, Clarke-MacIntyre, 10 apterous males, 1 winged male, 8 apterous females; Puyo, Oriente, Nov. 26, 1936, Clarke-MacIntyre, 1 apterous male, 2 apterous females, 1 winged female; Jatum Yacu, Oriente, E. Río Napo Watershed, 700 mtrs., Mar. 1937, Clarke-MacIntyre, 1 apterous male, 1 apterous female; Río Napo Watershed, Jan. 4, 1936, Clarke-MacIntyre, Note 3583, 24 apterous males, 1 winged male, 24 apterous females; Napo Watershed, Dec. 26, 1935, Wm. MacIntyre, Note 3581, 5 apterous males, 6 apterous females, 1 winged female; Partidero, Río Anzu, swift stream, P. T. No. 1, Oct. 29, 1935, Wm. MacIntyre, 26 apterous males, 13 apterous females.

* PERU: Vic. San Pedro, 900 m.a.s.l., pools and ponds, May 15-29, 1935, F. Woytkowski, 1 apterous male, 1 apterous female; Vic. San Pedro, 900 m.a.s.l., jungle pools, May 15-29, 1935, F. Woytkowski, 1 apterous male, 1 apterous female; Vic. Sani Beni, 840 m.a.s.l., River Sani Beni, Sept. 5, 1935, F. Woytkowski, No. 3551; 1 apterous male, 1 apterous female; Vic. Sani Beni, 840 m.a.s.l., River Sani Beni, from river, Oct. 9, 1935, F. Woytkowski, No. 3548, 2 apterous males, 2 apterous females; Vic. Río Negro, 790 m.a.s.l., shady brook in jungle, bed of clay, Oct. 29, 1935, F. Woytkowski, No. 3564, 9 apterous males, 11 apterous females; Vic. Río Negro, 790 m.a.s.l., in R. Negro, Nov. 4, 1935, F. Woytkowski, No. 3553e, 1 apterous male, 1 apterous female; Dept. Amazonas, Vic. Guayabamba, Andes, 1300 m.a.s.l, mountain brook, Aug. 14, 1936, F. Woytkowski, No. 3676, 4 apterous males, 2 apterous females; Dept. Amazonas, Vic. Guayabamba, Andes, 1300 m.a.s.l., muddy stream, Aug. 14-19, 1936, F. Woytkowski, No. 3665, 4 apterous males, 4 apterous females; Vic. Rioja, Dept. San Martín, jungle, 900 m.a.s.l., Sept. 9-Oct. 3, 1936, F. Woytkowski, No. 3682, 4 apterous males, 5 apterous females; Region Tarapoda, Dept. San Martín, 820 m.a.s.l., brook in village, Feb. 8, 1947, F. Woytkowski, 5 apterous males, 2 apterous females; Dept. Huánuco, Vic. Leonpampa, jungle, 800 m.a.s.l., forest pools, Dec. 12-14, 1937, F. Woytkowski, No. 383, 3 apterous males, 1 apterous female; Dept. Huánuco, Vic. Afilador, jungle brooks, 800 m.a.s.l., June 8-9, 1937, F. Woytkowski, No. 3767, 3 apterous males, 1 apterous female; Satipo, X-42, Pedro Paprzycki, 6 apterous males, 8 apterous females; Satipo, Nov. 1942, Pedro Paprzycki, 1 apterous male; Satipo, XII-42, Pedro Paprzycki, 1 apterous male, 2 apterous females.

Rhagovelia vivata Bacon

(Pl. IV, fig. 6)

1948. *Rhagovelia vivata* Bacon, Jour. Kansas Ent. Soc., vol. 21, No. 3, p. 85.

Size:	*Length*	*Width*
	3.67 mm. apterous male	1.39 mm. apterous male
	4.05 mm. apterous female	1.46 mm. apterous female
	4.78 mm. winged male	1.59 mm. winged male
	4.45 mm. winged female	1.45 mm. winged female

Color: General color black, covered with golden pubescence. Anterior portion of pronotum yellow becoming pruinose behind eyes. Venter dark gray to black, last abdominal segment black. Base of antennae, all coxae, anterior and posterior trochanters, and base of anterior femora yellow. Wings brown, slightly lighter in color at base.

Structural characteristics: Pronotum in apterous forms abbreviated, rounded behind and exposing much of mesonotum. *Apterous male:* anterior trochanter unarmed; anterior tibia only slightly dilate, flattened on apical third. Pronotum short (L. 27, W. 76); mesonotum truncate at apex and longer than pronotum (L. 40, W. 70); metanotum much wider than long (L. 10, W. 80). Proportions of antennae: Seg. I: II: III: IV:: 68: 38: 38: 40; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 148: 110: 52: 60; of posterior legs: 130: 104: 9: 26. Angle of taper of abdomen increases on last two segments. Abdomen with ventral median carina extending to last segment. Venter of last abdominal segment with slight median depression forming indistinct longitudinal trough. Posterior trochanter armed with from five to eight small, dark teeth. Posterior femur greatly incrassate (L. 130, W. 48); slightly flattened on ventral surface. Armed with two widely separated rows of spines. Anterior row begins at base and extends to apical one third; consists of approximately nine small spines. Posterior row begins on basal one third with dense cluster of small, subequal teeth followed by one long, black spine and seven smaller, decreasing spines to apex. Posterior tibia slightly arcuate and armed with closely set, irregularly placed teeth, and stout spur at apex. *Apterous female:* pronotum formed as in male (L. 30, W. 75); mesonotum as in male (L. 41, W. 76); metanotum also as in male (L. 9, W. 90). Proportions of antennae: 67: 40: 38: 37; of intermediate legs: 142: 105: 48: 60; of posterior legs: 117: 95: 8: 24. Abdomen tapers evenly to apex. Venter without median carina. Posterior trochanter unarmed. Posterior femur not as incrassate as in male (L. 117, W. 28) and armed before middle with one long spine followed by six decreasing spines to apex. Posterior tibia slightly arcuate; armed on basal half with two rows of small, subequal spines, apical half armed only with stout spur at apex. *Winged forms:* proportions and armature same as for apterous forms. Wings extend well beyond apex of abdomen. Pronotum not prolonged into a spiniform process.

Comparative notes: This species belongs in the group with *R. abrupta* Gould which has the pronotum abbreviated and rounded behind. It most nearly resembles *R. torquata* Bacon from which it can be separated by the armature of the posterior femur. The posterior trochanter of the male is armed with several dark teeth, and the basal half of the intermediate trochanter of the female is yellow in *R. vivata* Bacon, while in *R. torquata* Bacon the posterior trochanter is unarmed in the male, and the intermediate trochanter is black in the female. The male clasper is very distinctive and readily separates it from all other *Rhagovelia.*

Data on types: Holotype, apterous male; allotype, apterous female; holomorphotype, winged male; allomorphotype, winged female; paratypes, one apterous male, three apterous females; paramorphotypes, one winged male, two winged females. Described from series labeled: "Satipo, Perú, S. A., XII, 42, Pedro Paprzycki." All type specimens are in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on distribution: Recorded only from Perú. In addition to the type material, specimens from the following localities have been examined (new distribution records are indicated with an asterisk):

* BOLIVIA: R. Chapare, road between Tedos Santos and Palmer, March, 1938, A. M. Olalla, 12 apterous males, 6 apterous females.

PERU: Dept. Ayacucho, Prov. La Mar, Sivia, jungle, 790 m.a.s.l., Bks. Apurimac Riv., June 15-28, 1941, F. Woytkowski, No. 4212, 3 apterous males, 5 apterous females; Dept. Ayacucho, Prov. La Mar, Sivia, jungle, 790 m.a.s.l., stagnant boggy pools, June 18-19, 1941, F. Woytkowski, No. 428, 5 apterous males, 5 apterous females; Dept. Ayacucho, Prov. La Mar, Sivia, jungle, 79 m.a.s.l., stagnant pools, June 24-30, 1941, F. Woytkowski, No. 426, 1 apterous male, 1 winged male, 4 apterous females; Dept. Ayacucho, Prov. La Mar, Sivia, jungle, 790 m.a.s.l., slow flowing brooks, June 16, 1941, F. Woytkowski, No. 429, 1 apterous male, 1 apterous female; Dept. Ayacucho, Prov. La Mar, Sivia, jungle, 790 m.a.s.l., jungle brooks, June 24-30, 1941, F. Woytkowski, No. 425, 3 apterous males, 2 apterous females; Vic. Sani Beni, 840 m.a.s.l., brooks and pools of Sani Beni, Aug. 31, 1935, F. Woytkowski, Field Note 3560, 6 apterous males, 4 apterous females; Vic. Sani Beni, 840 m.a.s.l., brook on open cultivated land, Oct. 12, 1935, F. Woytkowski, No. 3566, 3 apterous males, 2 apterous females; Vic. Sani Beni, 840 m.a.s.l., tiny brook in jungle, Oct. 10, 1935, F. Woytkowski, No. 3557, 4 apterous males, 4 apterous females; Vic. Sani Beni, 840 m.a.s.l., canal supplying drinking water, Oct. 10, 1935, F. Woytkowski, No. 3562, 1 apterous female; Vic. San Pedro, 900 m.a.s.l., jungle pools, May 15-29, 1935, F. Woytkowski, 4 apterous males; Satipo, Nov. 1942, Pedro Paprzycki, 7 apterous males, 2 winged males, 2 apterous females, 5 winged females; Satipo, June and July, 1947, Pedro Paprzycki, 5 apterous males, 1 winged male, 3 apterous females, 2 winged females; Vic. Río Negro, 790 m.a.s.l., in Río Negro, Nov. 4, 1935, F. Woytkowski, No. 3553e, 1 apterous male.

ELEGANS GROUP

Group characteristics: The *elegans* group can be characterized as consisting of those species of the genus *Rhagovelia* with a hook-like or sickle-shaped spur at apex of the posterior tibia. The dorsum of the abdomen of the apterous female tapers rather evenly to the apex. Winged forms are fairly common; the wings just cover the apex of the genital segments.

The following species comprise this group:

1. *R. costalimai* Drake *
2. *R. elegans* Uhler
3. *R. insularis* Champion
4. *R. merga* sp. nov.
5. *R. trinidalis* Drake *
6. *R. uncinata* Champion

KEY TO SPECIES OF THE ELEGANS GROUP *

1. Last genital segment terminating in a spinelike process . . . . *uncinata*
Last genital segment rounded or triangular, but not spinelike at apex 2
2. (1) Posterior femur with only single row of spines; posterior tibia armed only on basal one half 3
Posterior femur with three rows of irregular spines; posterior tibia armed for entire length . . . . *merga*
3.†(2) Dorsum of abdomen with last two or three segments sparsely set with long brown hairs or long brown hairs absent; total length 4 to 5 mm. . . . . *insularis*
Dorsum of abdomen with all segments rather thickly beset with long brown hair; total length 4½ to 5¾ mm. . . . . *elegans*

Rhagovelia costalamai Drake

(Plate VIII, fig. 2)

1948. *Rhagovelia costalamai* Drake, Bol. de Ent. Venezolana, vol. 7, p. 142.

Size:	*Length*	*Width*
	5.20 mm. apterous male	1.85 mm. apterous male
	4.80 mm. apterous female	1.50 mm. apterous female
	5.50 mm. winged female	2.00 mm. winged female

Color: General color red-brown, clothed with fine golden pubescence. Pronotum with uninterrupted yellow band on anterior one fourth; also marked with a narrow, longitudinal midline, and faintly bordered on posterior margin with yellow-brown. Margins of connexiva yellow-brown. Venter light red-brown. Base of antennae, all coxae, anterior and posterior trochanters, and anterior femora underneath yellow. Winged form with same markings as in apterous forms. Wings brown.

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* The species *R. costalimai* Drake and *R. trinidalis* Drake are not included in this key as they were published after the key and main body of the paper were written.

† The two species brought out in this couplet are, in the opinion of the author, distinct species; however, no satisfactory characters distinguishing between them could be found.

Structural characteristics: Posterior tibia armed at apex with a hook. *Apterous male:* anterior trochanter unarmed. Anterior tibia slightly dilate and flattened within on apical one third. Pronotum wider than long (L. 89, W. 105); mesonotum exposed only at tip of pronotum (L. 2); metanotum much wider than long (L. 13, W. 115). Proportions of antennae: Seg. I: II: III: IV:: 96: 68: 46: 41; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 187: 145: 43: 68; of posterior legs: 172: 154: 11: 28. Abdomen tapers to apex, angle of taper increasing for last three segments. Venter with median carina sharply defined between posterior coxae, more slightly produced for remainder of abdomen. Posterior trochanter unarmed. Posterior femur moderately incrassate (L. 172, W. 35); armed with approximately six spines, the first of which is a long slender spine just before the middle and more widely spaced, the second spine is stouter and longer than the first, the third and fourth spines are shorter than the second with the fourth longer and stouter than the third, last two spines are stout and located close to apex. Posterior tibia straight; armed on basal two thirds with knoblike teeth and at apex with sickle-shaped spur. *Apterous female:* pronotum formed much as in apterous male (L. 76, W. 93); mesonotum as in male (L. 3); metanotum as in male (L. 11, W. 93). Proportions of antennae: 83: 55: 43: 37; of intermediate legs: 150: 113: 41: 63; of posterior legs: 136: 130: 11: 25. Posterior femur not as incrassate as in male (L. 136, W. 32); armed as in male. Posterior tibia formed and armed as in male. *Winged forms:* proportions and armature similar to apterous forms. Pronotum longer than wide (L. 125, W. 117). Coarsely punctate on posterior one half.

Comparative notes: This species is very close to *Rhagovelia insularis* Champion but can be separated from that form by the armature of the posterior femur and the larger size.

Data on types: The type series was taken in "Rio de Janeiro, Brazil, 11-6-38, by C. J. Drake." One apterous male, one apterous female, and one winged female paratypes are in the Francis Huntington Snow Entomological Collections of the University of Kansas. Other type material is in the personal collection of Dr. C. J. Drake.

Data on distribution: recorded only from Brazil.

Rhagovelia elegans Uhler

(Pl. IV, fig. 7)

1894. *Rhagovelia elegans* Uhler, Proc. Zool. Soc. London, p. 216.
1898. *Rhagovelia elegans,* Champion, Biol. Centr. Amer., Het., vol. 2, p. 131 (compares to *R. uncinata*)
1901. *Rhagovelia elegans,* Kirkaldy, Ento., vol. 34, p. 309 (mentions in key).
1931. *Rhagovelia elegans,* Gould, Kansas Univ. Sci. Bull., vol. 20, p. 30 (redescribes).
1931. *Rhagovelia elegans,* Drake and Harris, Pan Pacific Ent., vol. 8, p. 35 (record specimens from Grenada, West Indies).

Size: *Length*	*Width*
5.00 mm. apterous male	1.47 mm. apterous male
5.23 mm. apterous female	1.52 mm. apterous female
5.75 mm. winged male	1.83 mm. winged male
5.80 mm. winged female	1.99 mm. winged female

Color: General color red-brown, clothed with fine golden pubescence. Pronotum with uninterrupted yellow-brown band on anterior one fourth; also marked with a narrow, longitudinal midline, and bordered on posterior margin with yellow-brown. Venter lighter red-brown. Base of antennae, all coxae, anterior and posterior trochanters, and base of anterior femora yellow-brown. Winged forms with same type of markings on pronotum. Wings brown.

Structural characteristics: Posterior tibia armed at apex with a hook. *Apterous male:* anterior trochanter unarmed. Anterior tibia slightly arcuate; slightly dilate, and flattened on apical one third. Pronotum wider than long (L. 75, W. 95); mesonotum exposed briefly on midline (L. 8); metanotum much wider than long (L. 12, W. 105). Proportions of antennae: Seg. I: II: III: IV:: 90: 58: —: —; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 183: 144: 46: 67; of posterior legs: 167: 168: 14: 26. Abdomen tapers to apex, angle of taper increasing for last two segments. Venter with median carina between posterior coxae, evanescent for remainder of abdomen. Posterior trochanter unarmed. Posterior femur moderately incrassate (L. 167, W. 33); armed with approximately seven spines, the first of which is a long slender spine located just before middle, the second spine is stouter and longer than first, the third, fourth, and fifth spines are shorter than second and arranged in increasingly longer and stouter series, last two spines are short (scarcely longer than wide) and located close to apex. Posterior tibia straight; armed on basal one half with knob-like teeth and at apex with sickle-shaped spur. *Apterous female:* pronotum formed much as in apterous male (L. 74, W. 87); mesonotum as in male (L. 9); metanotum as in male (L. 12, W. 102).

Proportions of antennae: 92: 57: —: —; of intermediate legs: 165: 128: 45: 63; of posterior legs: 154: 155: 13: 28. Abdomen tapers to apex, angle of taper increasing for last three segments. Venter without median carina. Posterior trochanter unarmed. Posterior femur not as incrassate as in male (L. 154, W. 30); armed as in male. Posterior tibia formed and armed as in male. *Winged forms:* proportions and armature similar to apterous forms. Proportions of antennae of winged male: 87: 62: 45: 38; of winged female: 95: 60: 47: 38. Pronotum sparsely punctate with shallow punctures; portion posterior to humeri almost equilateral triangle; depressed on posterior one third; approximately as long as wide (L. 127, W. 125). Wings extend to just beyond apex of genital segment.

Comparative notes: This species resembles *R. insularis* Champion. *R. elegans* Uhler can be separated from *R. insularis* Champion by the shorter legs and antennae and by the armature of the posterior femur. The armature of the posterior femur is rather variable with some specimens being formed much as in *R. insularis* Champion, but examination of several specimens will show the typical *R. elegans* armature as the most prevalent type. The series of three increasing spines (the third, fourth and fifth) occurs infrequently in *R. insularis* Champion. Size also may be used as *R. elegans* Uhler is over five mm. in length while *R. insularis* Champion is smaller. The claspers of the male are of the same general type, and caution must be used in attempting to separate these two species by characters of the clasper alone.

Data on types: The type series was taken on the island of Grenada, in the British West Indies. One male cotype bearing the following data on collection: "Balthazar (windward side) Grenada, W. I., H. H. Smith, 18," is in the Francis Huntington Snow Entomological Collections, University of Kansas and is designated as the lectotype. Other type material is in the personal collection of Dr. C. J. Drake and in the British Museum.

Data on distribution: Recorded only from Grenada, British West Indies. In addition to the lectotype, specimens have been examined from the following localities:

BRITISH WEST INDIES: Dominica, No. 3A., Central, June 21, '37, Chester Roys, 1 apterous male, 5 winged males, 1 apterous female, 5 winged females; St. Vincent, Richmond Valley, 1800 ft., pool in forest stream, Dec. 31, H. H. Smith, 1 apterous male, 2 apterous females; Dominica, Layou River, June 15, '37, Chester Roys, 3 apterous males, 1 winged male, 4 apterous females, 2 winged females.

Rhagovelia insularis Champion

(Pl. IV, fig. 8)

1898. *Rhagovelia insularis* Champion, Biol. Centr. Amer., Het., vol. 2, p. 135.
1901. *Rhagovelia insularis*, Kirkaldy, Ento., vol. 34, p. 308 (mentions in key).
1931. *Rhagovelia insularis*, Gould, Kansas Univ. Sci. Bull., vol. 20, p. 34 (redescribes, records variations in structure; gives distribution as Trinidad, Panama, Brazil, and Colombia).
1944. *Rhagovelia insularis*, Hungerford, Zoologica, vol. 29, no. 3, p. 129 (new record for Venezuela).
1948. *Rhagovelia insularis*, Drake, Bol. de Ent. Venezolana, vol. 7, p. 141.

Size:	*Length*	*Width*
	4.54 mm. apterous male	1.66 mm. apterous male
	4.45 mm. apterous female	1.46 mm. apterous female
	5.16 mm. winged male	1.86 mm. winged male
	5.00 mm. winged female	1.75 mm. winged female

Color: General color red-brown to yellow-brown, clothed with golden pubescence. Anterior one fifth of pronotum with yellow band; pronotum also marked with indistinct median, longitudinal line and bordered on posterior margin with yellow; disc of pronotum lighter brown than remainder of dorsum. Dorsum of last two or three abdominal segments with median lighter areas. Connexiva margined with yellow-brown. Venter yellow-brown. Base of antennae, margins of all acetabulae, all coxae, anterior and posterior trochanters, and base of anterior and stripe beneath posterior femora yellow. Wings brown, veins darker.

Structural characteristics: Posterior tibia armed at apex with a hook. *Apterous male:* anterior trochanter unarmed; anterior tibia not dilate, flattened inside for apical one half. Pronotum wider than long (L. 72, W. 95); mesonotum exposed behind apex of pronotum (L. 9), or may occasionally be covered by apex of pronotum; metanotum short (L. 12, W. 100). Proportions of antennae: Seg. I: II: III: IV:: 77: 55: 40: 35; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 163: 122: 37: 62; of posterior legs: 150: 140: 10: 24. Abdomen tapers rather evenly to apex, angle of taper increasing for last three segments. Venter with well produced median carina between posterior coxae, becoming evanescent for remainder of abdominal segments. Posterior trochanter unarmed. Posterior femur moderately incrassate (L. 150, W. 34); armed with one row of approximately six spines beginning just before middle. The first and third spines moderately long, slender spines with the first being more widely spaced; the second and fourth spines stouter and somewhat longer; last two spines much shorter, knoblike spines and continue to apex. Posterior tibia slightly arcuate; armed on basal two thirds with subequal, small teeth and sickle-shaped spur at apex.

Apterous female: proportions of antennae: 67: 45: 35: 33; of intermediate legs: 138: 100: 39: 63; of posterior legs: 124: 120: 10: 25. Angle of taper of abdomen increases for last three segments. Venter without median carina. Posterior trochanter unarmed. Posterior femur as incrassate as in male (L. 124, W. 30) and armed as in male. Posterior tibia formed and armed as in male. *Winged forms:* proportions and armature same as for apterous forms. Pronotum approximately as long as wide (L. 127, W. 126); depressed on posterior one third, punctured in varying degrees from sparsely to thickly; portion behind humeri forming equilateral triangle. Wings extend to just beyond apex of genital segments.

Comparative notes: This species resembles *R. elegans* Uhler. *R. insularis* Champion can be separated from *R. elegans* Uhler by the smaller size, and armature of the posterior femur. As has been noted by Gould (1931; p. 34) *R. insularis* Champion is somewhat variable as to size and color as well as to armature of the posterior femur, however most specimens will fit rather closely to the typical form.

Data on types: Champion's type material is in the British Museum. The type locality is given as: "Panama, San Miguel in the Pearl Islands." Both apterous and winged forms of both sexes are represented.

Data on distribution: Recorded from Trinidad, Panamá, Brazil, and Colombia. Specimens from the following localities have been examined (new records on distribution for major political areas are indicated with an asterisk):

BRAZIL: Utinga Belem, Pará, VIII, 1946, L. & M. Deane, 55 apterous males, 5 winged males, 81 apterous females, 6 winged females; Utinga Belem, Nov. 1946, L. & M. Deane, 1 apterous male, 5 winged males, 6 apterous females, 2 winged females; Lago Grande, State of Pará, Feb. '39, A. M. Olalla, 2 apterous males, 6 apterous females, 1 winged female; Manscapuru, Amazonas, Solimoes River, 6-26, S. M. Klages, 3 winged males, 4 apterous females, 2 winged females.

BRITISH WEST INDIES: St. Kitts, Windfield River, May 30, '37, Chester Roys, 11 apterous males, 2 winged males, 13 apterous females, 4 winged females; Trinidad, Port of Spain (J. R. de la Torre-Bueno Collection), 5 apterous males, 2 winged males, 12 apterous females, 2 winged females; Trinidad, Port of Spain, Nov. 5, 1931, W. E. Broadway, 2 apterous males, 1 winged male, 4 apterous females.

* CANAL ZONE: Barro, Colo. Isld., 1-3-29, C. H. Curran (U. S. Nat. Mus. Collection), 3 apterous males, 3 winged males, 1 apterous female; Ft. Clayton, 11-11-32, Capt. R. F. Edwards, 4 apterous males, 5 winged males, 12 apterous females, 3 winged females; Summit, 20-47, N. L. H. Krauss, 4 apterous males, 2 winged males, 5 apterous females.

COLOMBIA: Gorgona Is., 2.59 N. 78.20 W. July, 1924, Miss Cheesman (exchange with British Museum), 3 apterous females, 1 nymph.

PANAMA: Taboga Is., 24.ix. 1924, Miss Cheesman (exchange with British Museum), St. George Exp., B. M. 1924, 459, 3 apterous males, 1 winged male, 1 apterous female.

VENEZUELA: San Esteban, Nov. 22, 1939, Pablo J. Anduze, 1 apterous male, 1 winged male; Caripito, IV-1942, Wm. Beebe, 2 apterous males, 3 apterous females.

Rhagovelia merga sp. nov.

(Pl. IV, fig. 9)

Size:	*Length*	*Width*
	5.05 mm. apterous male	1.66 mm. apterous male

Color: General color red-brown, clothed with golden pubescence. Anterior band of pronotum only slightly lighter than disc of pronotum. Venter practically unicolorous.

Structural characteristics: Posterior tibia armed at apex with sickle-shaped spur. *Apterous male:* anterior trochanter unarmed; anterior tibia straight, flattened within, not dilate, and slightly excavate on anterior one fifth. Pronotum punctate, rounded behind (L. 72, W. 90); mesonotum hidden by apex of pronotum; metanotum short on midline (L. 10, W. 107). Proportions of antennae: Seg. I: II: III: IV:: 94: 54: 58: 50; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 173: 128: 48: 68; of posterior legs: 190: 190: 20: 34. Margins of connexiva almost parallel except for last two segments which taper to apex. Venter with median carina well-defined at first, becoming evanescent on last two abdominal segments. Minute, conical black setae on jugum of head and proepisternum. Posterior trochanter armed with a group of six to eight small, subequal teeth. Posterior femur greatly incrassate (L. 190, W. 57); armed for entire length of ventral surface with subequal, small, dark-tipped spines, irregularly arranged in at least two rows; in addition to the small spines there is one very large spine (L. 32) set at middle on posterior margin of ventral surface. Posterior tibia straight; inner margin swollen and beset with larger black teeth at basal one fifth; armed within for entire length with two rows of subequal black teeth; armed at apex with sickle-shaped spur. *Apterous female:* unknown. *Winged forms:* unknown.

Comparative notes: This species resembles *R. elegans* Uhler, but can be separated from that species by the armature of the posterior femur which in *R. elegans* Uhler consists of only a single row of spines. The peculiar shape of the posterior tibia which is armed with two rows of teeth, and the armed posterior trochanter of *R. merga* sp. nov. will further serve to separate the males of these two species. The clasper of the male is quite distinct and readily separates *R. merga* sp. nov. from all other *Rhagovelia.*

Data on types: The holotype is an apterous male and is the only type specimen. Data on collection is as follows: "Boquete, Panama, Chiriqui Prov., May 15, 1923, 512, F. M. Gaige." (J. R. de la Torre-Bueno Collection, Kansas University). The holotype is in the Francis Huntington Snow Entomological Collections of the University of Kansas.

Data on distribution: Known only from the type series.

Rhagovelia trinidalis Drake

1948. *Rhagovelia trinidalis* Drake, Bol. de Ent. Venezolana, vol. 7, p. 143.

This species is not represented in the material in the Francis Huntington Snow Entomological Collections, University of Kansas. The original description is quoted below:

"Apterous form: Head black, flavous in front, with usual impressed spots and lines; eyes brownish black. Rostrum black at tip extending beyond prosternum. Antennae dark fuscous-brown, beset with long bristly hairs, the first segment bowed, flavous at base; antennal proportion I. 62; II. 42; III. 30; IV. 25. Pronotum long, rounded behind, dark reddish fuscus, with anterior lobe and hind margin flavous, coarsely pitted, wider than long (70:55).

"Abdomen dark fuscous densely clothed with short golden hairs, connexiva narrowed posteriorly, margined with flavous; beneath testaceous, darker along sides, with longer and more shaggy hairs, the last venter truncate behind, slightly longer than preceding segment.

"Length, 4.60 mm.; width, 1.40 mm.

"*Male:* Middle femora flavous beneath, brownish black above, unarmed; tibiae brownish black, more densely hairy, third tarsal segment longer than second (45: 32); proportions—femora, 145; tibiae, 105. Hind femora moderately swollen, armed beneath with four long and two or three much shorter apical spines, the first long spine placed a little before the middle; tibiae slightly bowed, dentate within, the teeth short blunt and black; proportions—femora, 120; tibiae, 112. Coxae, trochanters and acetabula pale flavous. Left clasper spatulate, deeply excavated before the middle, beset with numerous long hairs on outer surface, the tip of the blade rounded.

"*Female:* About same size and color as male. Hind femora a little less incrassate, the spines beneath somewhat shorter.

"*Macropterous form:* pronotum triangularly produced behind. Hemelytra longer than abdomen, black-fuscous, the veins not prominent.

"Length, 5.10 mm.; width, 1.60 mm. Winged form is a little longer than apterous.

"*Type* (apterous male) and *allotype* (apterous female). Trinidad, B. W. I., Oct. 27-29, 1938, C. J. Drake. *Paratypes:* many apterous and macropterous examples taken in a small stream with type.

"This species is most closely allied to *R. elegans* Uhler (type from Grenada), and may be separated from it by the shorter hind femora and tibiae and shorter claspers. In *R. elegans,* the hind femora within are armed within with six long spines and two or three short apical ones; right clasper is broader and not as deeply notched."

Comparative notes: This species was described after the body of this paper was written and too late to attempt to obtain paratype specimens from Dr. Drake for comparative study.

Rhagovelia uncinata Champion

(Pl. IV, fig. 10)

1898. *Rhagovelia uncinata* Champion, Biol. Centr. Amer., Het., vol. 2, p. 135.
1901. *Rhagovelia uncinata,* Kirkaldy, Ento., vol. 34, p. 308 (mentions in key).
1931. *Rhagovelia uncinata,* Gould, Kansas Univ. Sci. Bull., vol. 20, p. 46 (redescribes).
1948. *Rhagovelia uncinata,* Drake, Bol. de Ent. Venezolana, vol. 7, p. 141.

Size:	*Length*	*Width*
	4.86 mm. apterous male	1.46 mm. apterous male
	4.35 mm. apterous female	1.33 mm. apterous female
	5.15 mm. winged male	1.78 mm. winged male
	5.05 mm. winged female	1.66 mm. winged female

Color: General color yellow-brown, clothed with golden pubescence. Pronotum with band on anterior one fifth, longitudinal line down middle, and posterior border yellow. Dorsum of abdomen and metanotum with median yellow areas. Margins of connexiva yellow. Venter yellow, as are all coxae, trochanters and all femora when viewed from beneath, femora from above appear dark brown except base of anterior femur and posterior femur which have lighter areas at both base and apex. Wings brown, veins black.

Structural characteristics: Posterior tibia armed at apex with sickle-shaped spur. *Apterous male:* anterior trochanter unarmed; anterior tibia straight, only slightly dilate and flattened within for apical two thirds. Pronotum wider than long (L. 78, W. 93) and punctate after the anterior band; mesonotum generally covered by apex of pronotum; metanotum short on midline (L. 8, W. 95). Proportions of antennae: Seg. I: II: III: IV:: 90: 60: 43: 38; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 168: 130: 35: 63; of posterior legs: 157: 136: 10: 25. Abdomen tapers rather evenly to apex, angle of taper increasing on last two segments. Terminal genital segment produced in sharp spine at apex. Venter with slight median carina becoming evanescent on last abdominal segment. Sparsely beset on jugum of head and proepisternum with minute conical, black setae. Posterior trochanter unarmed. Posterior femur moderately incrassate (L. 157, W. 30) and armed with one row of approximately seven spines. The first spine is a moderate spine located just after basal one third, and widely spaced from the rest; the second spine is located just beyond middle and is larger and stouter than first; remaining spines consist of two or three moderate, and two or three small knoblike spines. Rarely there is one very small spine before spine at basal one third; this small spine may be present on one femur and not on other, or may be on both femora, or absent. Posterior tibia slightly arcuate; armed on inside with small, subequal teeth and sickle-shaped spur at apex. *Apterous female:* pronotum formed as in apterous male (L. 68, W. 84). Proportions of antennae: 67: 43: 37: 34; of intermediate legs: 142: 103: 33: 62; of posterior legs: 124: 115: 8: 25. Abdomen tapers rather evenly to apex. Terminal genital segment produced in sharp spine at apex. Venter with well-defined ventral carina between posterior coxae, inconspicuous for remainder of venter. Sparsely beset on jugum and proepisternum with minute, conical, black setae as in male. Posterior trochanter unarmed. Posterior femur formed and armed as in male. Posterior tibia as in male. *Winged forms:* pronotum longer than wide (L. 123, W. 117); depressed on posterior one half; deeply punctured. Wings just covering apex of genital segments. Proportions and armature same as for apterous forms. Genital segments formed as in apterous forms.

Comparative notes: This species resembles *R. insularis* Champion. The elongate, spinelike terminal genital segment of all forms of *R.*

uncinata Champion will serve to separate it from *R. insularis* Champion.

Data on types: Champion's type material is mostly in the British Museum. One pair of cotypes collected in Bugaba, Panama, by Champion and bearing an additional label: "B. C. A. Rhyn. II, *Rhagovelia uncinata* Ch." are in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on distribution: Recorded only from Panama. In addition to the type material, specimens from the following localities have been examined (new distribution records for major political areas are indicated with an asterisk):

* COSTA RICA: San Isidro del. Gen., 2000 ft., Feb. 1939, Dean L. Rounds, 4 apterous males.

PANAMA: El Valle, Jan. 1947, N. L. H. Krause, 11 winged males, 3 apterous females, 15 winged females.

CRASSIPES GROUP

Group characteristics: The *crassipes* group can be characterized as consisting of those species of the genus *Rhagovelia* in which the dorsum of the abdomen of the apterous female is broad and tapered more or less evenly to the apex, the intermediate femur of the female is cylindrical, the posterior tibia of all forms is without a sickle-shaped spur, and the pronotum of the apterous forms covers the mesonotum. Winged forms are comparatively rare; the wings just cover the apex of the genital segments.

The following species comprise this group:

1. *R. amazonensis* Gould
2. *R. castanea* Gould
3. *R. crassipes* Champion
4. *R. femoralis* Champion
5. *R. horrida* sp. nov.
6. *R. jubata* Bacon
7. *R. nitida* Bacon
8. *R. ornata* Bacon
9. *R. palea* sp. nov.
10. *R. panda* Drake and Harris
11. *R. perfidiosa* Bacon
12. *R. relicta* Gould
13. *R. robusta* Gould
14. *R. scitula* sp. nov.
15. *R. sinuata* Gould
16. *R. varipes* Champion
17. *R. whitei* (Breddin)
18. *R. williamsi* Gould

KEY TO SPECIES OF THE CRASSIPES GROUP

1. Denticulation of posterior tibia of male composed of subequal teeth (apical spur excepted) 2

Denticulation of posterior tibia with some teeth noticeably larger than others 6

2. (1) Posterior trochanter of male unarmed; posterior tibia of female unarmed .... *nitida*

Posterior trochanter armed with at least two or three small teeth; posterior tibia of female armed at least on basal one half 3

3. (2) Posterior trochanter of male armed with two to four small, subequal teeth; anterior band of pronotum not definitely marked off from disc of pronotum in female . . . . . . *sinuata*

Posterior trochanter of male armed with one longer tooth and several small subequal teeth; pronotal band definitely marked off from disc of pronotum in female 4

4. (3) Proepisternum beset with minute, conical, black setae along inner portion . . . . . . *perfidiosa*

Proepisternum without such minute, conical, black setae 5

5. (4) Posterior femur of male armed with one moderate spine at basal ⅛ with a longer spine at middle followed by decreasing series to apex; dorsum of first genital segment of female longer than wide (L. 30, W. 24) . . . . . . *williamsi*

Posterior femur of male armed with a long spine at middle followed by a decreasing series to apex; dorsum of first genital segment of female wider than long (L. 21, W. 27), *amazonensis*

6. (1) Posterior trochanter of male with one tooth much larger than the rest, or apparently armed with only one long tooth, longer than teeth on tibia 7

Posterior trochanter with all teeth subequal in length, or only one tooth subequal or smaller in size than teeth on tibia 11

7. (6) Without minute, conical, black setae on proepisternum . . *castanea*

Minute, conical, black setae at least on proepisternum 8

8. (7) Minute, conical, black setae in a cluster on posterior ⅛ of venter of last abdominal segment at the sides 9

All setae hairlike on sides of venter of last abdominal segment . . 10

9. (8) Intermediate trochanter dark brown to black . . . . . . *jubata*

Intermediate trochanter yellow . . . . . . *palea*

10. (8) Median yellow-brown spots on dorsum of last three or four abdominal segments, posterior tibia of male cylindrical . . *scitula*

Median spots on dorsum of last three segments dark brown; posterior tibia of male flattened . . . . . . *whitei*

11. (6) Minute, black, conical setae present on posterior edge of venter of last abdominal segment at the sides in the male 12

No minute, black, conical setae on posterior edge of venter of last abdominal segment at the sides of the male 15

12. (11) Venter of male with pronounced median carina which has abdomen depressed on each side and extends for more than basal three segments 13

Venter of male may or may not have median carina, if present the carina extends only on basal three segments of abdomen and abdomen is not depressed on each side 14

13. (12) Antennae of all forms with apical two segments subequal in length; apex of pronotum of winged forms yellow . . . *horrida*

Antennae of all forms with last segment of antennae definitely shorter than preceding segment; apex of pronotum of winged forms same color as disc of pronotum . . . . . . *panda*

14.(12) Posterior femur of male armed with approximately six irregular rows of spines; two or three teeth on posterior tibia of male much larger than the rest. Posterior femur of female armed at about the middle with longest spine . . . . *crassipes*

Posterior femur of male armed with approximately three rows of spines; teeth of apical one half of posterior tibia of male increasing gradually in size. Posterior femur of female armed at the apical one third with longest spine . . . . *varipes*

15.(11) No minute, conical, black setae on base of jugum of head or on proepisternum; size 5.5-6.5 mm. *ornata*

Minute, black, conical setae or minute bristlelike setae scattered sparsely on base of jugum of head and on proepisternum, may be only two or three but always present; size 4-5.5 mm. 16

16.(15) Minute, black setae on proepisternum elongate so as to appear almost bristlelike . . . . *femoralis*

Minute, black setae conical or appear merely as black dots 17

17.(16) Intermediate trochanter yellow to yellow-brown; posterior femur of male armed with four or five irregular rows of spines, *robusta*

Intermediate trochanter dark brown to black; posterior femur of male armed with two or three rows of spines . . . . *relicta*

Rhagovelia amazonensis Gould

(Pl. V, fig. 1)

1931. *Rhagovelia amazonensis* Gould, Kansas Univ. Sci. Bull., vol. 20, p. 15.

1935. *Rhagovelia williamsi*, Drake and Harris (*nec* Gould) Proc. Biol. Soc. Washington, vol. 48, p. 33 (incorrectly places *R. williamsi* Gould as a synonym of *R. amazonensis* Gould).

Size:	*Length*	*Width*
	3.20 mm. apterous male	1.13 mm. apterous male
	3.65 mm. apterous female	1.19 mm. apterous female

Color: General color dark brown to red-brown, clothed with golden pubescence. Pronotum with anterior band broadly orange, becoming more or less pruinose at sides. Dorsum of first abdominal segment at sides and fourth abdominal segment pruinose. Margins of connexiva orange. Venter gray-black to red-brown. Venter of last abdominal segment orange beneath. Base of antennae, margins of all acetabulae, anterior and posterior trochanters (intermediate trochanter in part), and base of anterior and posterior femora light brown to yellow.

Structural characteristics: Pronotum of apterous forms covers mesonotum. Dorsum of abdomen of apterous female tapers evenly to apex. Posterior tibia without sickle-shaped spur at apex. *Apterous male:* anterior trochanter unarmed. Anterior tibia only slightly dilate and flattened within. Pronotum broadly rounded behind (L. 50, W. 67) and covering mesonotum. Metanotum short on midline (L. 7, W. 69). Proportions of antennae: Seg. I: II: III: IV:: 50: 27: —: —; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 113: 85: 32: 50; of posterior legs: 92: 76: —: —. Abdomen tapers rather evenly to apex with angle of taper increasing for last three segments. Connexiva semi-vertical. Venter without median carina. No minute, conical, black setae on proepisternum. Venter of last abdominal segment depressed on posterior one third beneath. Posterior trochanter armed with one to three short teeth and one longer tooth. Posterior femur moderately incrassate (L. 92, W. 23); armed on basal one third with one row of closely set small spines; armed just before middle with one long spine followed by seven or eight shorter, gradually decreasing spines to apex; armed on apical one third with anterior row of several short, subequal spines. Posterior tibia slightly arcuate and armed within with two rows of subequal teeth and slender spur at apex. *Apterous female:* anterior tibia as in male. Pronotum as in male (L. 58, W. 73); metanotum as in male (L. 7, W. 76). Proportions of antennae: 50: 29: 30: 29; of intermediate legs: 116: 87: 32: 52; of posterior legs: 97: 82: 5: 22. Dorsum of abdomen tapers evenly to apex. Connexiva semivertical to vertical. Dorsum of first genital segment wider than long (L. 21, W. 30). Posterior trochanter unarmed. Posterior femur moderately incrassate (L. 97, W. 22); armed with one small spine approximately midway of basal one third; armed at middle with one long spine followed by six or eight rapidly decreasing spines to apex; armed on apical one fourth with one row of three or four subequal, small spines. Posterior tibia slightly arcuate; armed within with two rows of small subequal teeth and spur at apex. *Winged forms:* unknown.

Comparative notes: This species resembles *R. williamsi* Gould. *R. amazonensis* Gould can be separated from *R. williamsi* Gould by the armature of the posterior femur of the male which does not have a moderate sized spine preceding the long spine at the middle, and by the wider than long dorsum of the first genital segment of the female. The longer hairs and the golden pubescence of the dorsum of the female are arranged differently in the two species, being present on all of the first three abdominal segments in *R. amazonensis* Gould while in *R. williamsi* Gould those longer hairs and golden pubescence are absent from the dorsum of the second abdominal segment. The claspers of the male are similar in shape, but those of *R. amazonensis* Gould are smaller than those of *R. williamsi* Gould.

Data on types: Holotype, apterous male; allotype, apterous female; paratypes, 36 apterous females. The type series was collected in Manacapuru, Amazonas, Brazil, Solimoes River, April, 1926, S. M. Klages. The above type series is in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on distribution: Known only from the type series.

Rhagovelia castanea Gould

(Pl. V, fig. 2)

1931. *Rhagovelia castanea* Gould, Kansas Univ. Sci. Bull., vol. 20, p. 19.

Size:

Length	*Width*
4.20 mm. apterous male	1.46 mm. apterous male
4.35 mm. apterous female	1.46 mm. apterous female

Color: General color red-brown, varying in shade from light to dark. Clothed with golden pubescence. Anterior band of pronotum lighter in color than disc which has median line and posterior one half lighter red-brown. Venter and appendages same color as dorsum.

Structural characteristics: Pronotum of apterous forms covers mesonotum. Dorsum of abdomen of apterous female tapers evenly to apex. Posterior tibia without sickle-shaped spur at apex. *Apterous male:* anterior trochanter unarmed. Anterior tibia flattened within and only slightly dilate toward apex. Pronotum rather sharply rounded behind (L. 70, W. 83). Metanotum short on midline (L. 11, W. 92). Proportions of antennae: Seg. I: II: III: IV:: 80: 51: 45: 39; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 170: 125: 45: 72; of posterior legs: 153: 140: 9: 30. Abdomen tapers gradually at first, angle of taper increasing for last three segments. Connexiva semivertical. Venter without median carina. Base of jugum of head, proepisternum and last abnominal segment without minute, black, conical setae. Posterior trochanter armed with four or five small teeth and one larger tooth. Posterior femur greatly incrassate on most specimens (L. 153, W. 50); armed on basal one third with one row of inconspicuous spines followed after the basal one third with one moderate spine, with diastema between it and longer spine at apical one third which is followed by four or five rapidly decreasing spines to apex; also armed with anterior row of irregularly placed teeth after middle, and one long spine set at apical one third on anterior margin of ventral surface of femur. Posterior trochanter arcuate; armed within with two rows of teeth increasing in size toward apex, with last tooth enlarged; armed at apex with stout spur. *Apterous female:* anterior leg as in male.

Pronotum broadly rounded behind (L. 67, W. 82). Metanotum as in male (L. 9, W. 90). Proportions of antennae: 77: 45: 42: 40; of intermediate legs: 153: 110: 40: 58; of posterior legs: 130: 118: 8: 27. Dorsum of abdomen tapers evenly to apex. Connexiva semivertical. Posterior trochanter unarmed. Posterior femur moderately incrassate (L. 130, W. 30); armed on basal one half with from no to two or three small spines and one moderate spine before the middle; armed at middle with one long spine followed by six or seven smaller, rapidly decreasing spines to apex; also armed with anterior row of small spines on apical one fourth. Posterior tibia slightly arcuate; armed within with two rows of subequal teeth; armed at apex with stout spur. *Winged forms:* unknown.

Comparative notes: This species resembles *R. palea* sp. nov. *R. castanea* Gould can be separated from *R. palea* sp. nov. by the lack of the minute, conical, black setae on the proepisternum in all forms.

Data on types: Holotype, apterous male; allotype, apterous female; paratypes, 9 apterous males, 5 apterous females. The type series was collected in Ecuador, Feb. 11, 1923, by F. X. Williams, and is located in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on distribution: In addition to the type series, specimens from the following localities have been examined:

ECUADOR: Mera, 11-14-36, Clarke-MacIntyre, 43 apterous males, 29 apterous females; Partidero, Río Anzu, swift stream, P. T. No. 1, Oct. 29, 1935, Wm. MacIntyre, 1 apterous male; Nov. 1935, Wm. MacIntyre, 2 apterous males, 4 apterous females; Napo Watershed, Dec. 26, 1935, Wm. MacIntyre, 1 apterous male, 1 apterous female; Río Napo Watershed, Jan. 4, 1936, Clarke-MacIntyre, 2 apterous males, 2 apterous females.

Rhagovelia crassipes Champion

(Pl. V, fig. 3)

1898. *Rhagovelia crassipes* Champion, Biol. Centr. Amer. Het., vol. 2, p. 133.
1901. *Rhagovelia crassipes*, Kirkaldy, Ent., vol. 34, p. 308.
1931. *Rhagovelia crassipes*, Gould, Kansas Univ. Sci. Bull., vol. 20, p. 25.

Size:	*Length*	*Width*
	6.10 mm. apterous male	1.80 mm. apterous male
	5.97 mm. apterous female	1.80 mm. apterous female
	7.30 mm. winged male	2.38 mm. winged male
	6.50 mm. winged female	2.32 mm. winged female

Color: General color red-brown to brown-black, clothed with golden pubescence. Anterior band of pronotum yellow behind vertex of head, becoming pruinose behind eyes. Median yellow shining area on dorsum of last abdominal segment. Margins of connexiva indistinctly yellow. Venter red-brown; some specimens show venter of thorax and first two abdominal segments almost black. Venter of last abdominal segment yellow beneath. Base of antennae, all coxae and trochanters yellow. Wings brown; veins black. Spine at apex of pronotum slightly lighter in color than disc of pronotum.

Structural characteristics: Pronotum of apterous forms covers mesonotum. Dorsum of abdomen of apterous female tapers evenly to apex. Posterior tibia without sickle-shaped spur at apex. *Apterous male:* anterior trochanter unarmed. Anterior tibia not dilate; flattened within. Pronotum rounded behind (L. 100, W. 111). Metanotum short on midline (L. 15, W. 119). Proportions of antennae: Seg. I: II: III: IV:: 108: 66: 50: 43; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 205: 145: 58: 78; of posterior legs: 200: 180: 20: 37. Abdomen tapers rather evenly to apex, angle of taper increasing for last three segments. Minute, conical, black setae on base of jugum of head, on proepisternum, and on venter except last segment of abdomen where black, conical setae are concentrated in row along sides of posterior edge. Venter with metasternum raised in center with segment depressed to each side; median carina well developed on basal three or four segments of abdomen becoming evanescent on fifth. Posterior trochanter armed with ten to twenty small, subequal teeth. Posterior femur greatly incrassate (L. 200, W. 40); armed on basal one fourth with one row of small, subequal teeth; armed after basal one fourth with approximately six irregular rows of spines, the anterior three rows are all small, subequal spines, one larger row of stout spines set on mid-ventral line of femur begins at basal one third with widely-spaced, moderate spines, followed by four or five smaller, subequal spines, then two moderate spines and three or four smaller, decreasing spines to apex; the posterior portion of ventral surface is armed on apical one half with two irregular rows of three or four small, scattered, subequal spines. Posterior tibia curved in at first then curved slightly outward at apical one third; armed with two rows of teeth with one greatly enlarged tooth at approximately apical one third, one shorter next to it and another near the apex; armed at apex with stout spur. On some specimens posterior femur is only moderately incrassate, when this is true armature is reduced in size but follows same general pattern. *Apterous female:* anterior tibia as in male. Pronotum broadly rounded behind (L. 91, W. 112). Metanotum as in male (L. 7, W. 115). Proportions of antennae: 96: 60: 48: 42; of intermediate legs: 183: 135: 53: 74; of posterior legs: 162: 158: 16: 35. Dorsum of abdomen tapering evenly to apex. Connexiva semivertical. Metasternum and abdomen not carinate. Minute, conical, black setae as in male. Posterior trochanter usually armed with from one to three small, dark teeth. Posterior femur not as incrassate as in male (L. 162, W. 40); armed before middle with one long spine followed by approximately six small, subequal spines beginning beyond middle and continuing to apex. Posterior tibia straight; armed within with two rows of teeth with tooth before apex somewhat enlarged; armed at apex with stout spur. *Winged forms:* proportions and armature similar to apterous forms. Wings just cover apex of genital segments. Pronotum in both sexes continued into moderate spine at apex (L. 25).

Comparative notes: This species resembles *R. varipes* Champion. *R. crassipes* Champion can be separated from *R. varipes* Champion by the armature of the posterior femur. The posterior femur of the male of *R. crassipes* Champion is armed with six or seven irregular rows of spines while that of *R. varipes* Champion has only two. The posterior femur of the female of *R. crassipes* Champion is armed near the middle with a long spine followed by five or six smaller spines while that of *R. varipes* Champion is armed with one small spine near the middle followed by a long spine at the apical one third and five smaller decreasing spines to the apex.

Data on types: Champion's type material is, in greater part, in the British Museum. The type locality is given as Panamá, Tolé, and Peña Blanca. Two apterous females labeled: "Peña Blanca, 3000-4000 ft., Champion." and bearing a second label: "B. C. A. Rhyn. II, Rhagovelia crassipes Ch.", are in the Francis Huntington Snow Entomological Collections, University of Kansas. The two specimens are cotypes.

Data on Distribution: Recorded only from Panama. In addition to the cotypes mentioned above, specimens from the following localities have been examined:

PANAMA: Feb. 4, 1935, Col. by J. W. McSwain for Robert Wind, 37 winged males, 72 winged females; Potrerillos, 2-22-1935, D. V. Brown, 1 winged male, 6 winged females; Potrerillos, 2-20-1935, D. V. Brown, 3 winged males, 2 winged females; Potrerillos, 2-15-1935, D. V. Brown, 7 winged males, 4 winged females; Potrerillos, 2-18-1935, D. V. Brown, 10 winged males, 13 winged females; Potrerillos, 3-9-1935, 5 winged males, 2 winged females; Potrerillos, 2-25-1935, D. V. Brown, 3 winged males, 11 winged females; El Valle, Jan., 1947, N. L. H. Krauss, 3 apterous males, 2 apterous females.

Rhagovelia femoralis Champion

(Pl. V, fig. 4)

1898. *Rhagovelia femoralis* Champion, Biol. Centr. Amer. Het., vol. 2, p. 138.
1901. *Rhagovelia femorata,* Kirkaldy, Ent., vol. 34, p. 308.
1914. *Rhagovelia femoralis,* Bergroth, Psyche, vol. 21, p. 74.
1927. *Rhagovelia femoralis,* Drake and Harris, Proc. Biol. Soc. Washington, vol. 40, p. 131.
1931. *Rhagovelia femoralis,* Gould, Kansas Univ. Sci. Bull., vol. 20, p. 30.

Size:	*Length*	*Width*
	5.05 mm. apterous male	1.46 mm. apterous male

Color: General color black, clothed with golden pubescence. Anterior band of pronotum yellow behind vertex of head becoming pruinose behind eyes. Margins of connexiva dark brown. Shining brown to black median area on dorsum of last abdominal segment. Venter brown-black. Venter of last abdominal segment orange beneath. Base of antennae, margins of all acetabulae, all coxae, anterior and posterior trochanters, intermediate trochanter in part, and anterior and posterior femora beneath yellow.

Structural characteristics: Pronotum of apterous male covers mesonotum. Posterior tibia without sickle-shaped spur at apex. *Apterous male:* anterior trochanter unarmed. Anterior tibia slightly dilate toward apex and flattened within. Pronotum rounded behind (L. 85, W. 87). Metanotum short on midline (L. 11, W. 94). Proportions of antennae: Seg. I: II: III: IV:: 80: 40: —: —; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 160: 137: 60: 67; of posterior legs: 145: 127: 15: 30. Abdomen tapers evenly to apex. Connexiva semivertical. Venter of abdomen with distinct ventral carina extending to last segment. Proepisternum set with minute, black, elongate or bristlelike setae along inner surface. Venter of last abdominal segment distinctly excavate in middle on posterior one half. Posterior trochanter armed with three to five small, dark, subequal teeth. Posterior femur greatly incrassate (L. 145, W. 54); armed on basal one third with row of closely-spaced small subequal teeth; apical two thirds armed with two rows of spines, the posterior row consists of one long spine just after basal one third followed by two short, three moderate, and one short spine to apex, the anterior row consists of nine or ten subequal, small spines beginning after basal one third and continuing to apex. Posterior tibia slightly arcuate on basal two thirds, curved slightly outward on apical one third; armed with two rows of subequal teeth with one tooth before apical one third greatly enlarged; armed at apex with stout spur. *Apterous female:* unknown. *Winged forms:* unknown.

Comparative notes: This species resembles *R. relicta* Gould. *R. femoralis* Champion can be separated from *R. relicta* Gould by the possession of a distinct ventral carina extending for at least five segments on the venter of the abdomen of the male. The apterous male is the only form of this species which has been described and the further clarifying of its range of variation and probable relationships must await further collections. Dr. Hungerford examined the type of this species in the British Museum in 1928 and indicated it was a close relative of *R. relicta* Gould and *R. robusta* Gould but was distinct from either of those species.

Data on types: Champion's types are in the British Museum. This species was described from a single apterous male collected in Panama, Peña Blanca, by Champion.

Data on distribution: Recorded only from Panama. One specimen of this species has been examined from the following locality:

PANAMA: Potrerillos, 2-22-1935, D. V. Brown. 1 apterous male.

Rhagovelia horrida sp. nov.

(Pl. V, fig. 5)

Size:	*Length*	*Width*
	4.25 mm. apterous male	1.47 mm. apterous male
	4.50 mm. apterous female	1.59 mm. apterous female
	4.98 mm. winged male	1.73 mm. winged male
	4.85 mm. winged female	1.79 mm. winged female

Color: General color dark brown, covered with golden pubescence. Head with frons yellow and vertex brown; on some specimens there is small, median, yellow spot on posterior border of vertex. Anterior portion of pronotum with broad uninterrupted yellow band; disk of pronotum very dark brown; apex of pronotum yellow. Anterior basal cell of wing pruinose. Wings lighter brown than thorax. Connexival margins broadly yellow. Dorsum of abdomen pruinose at each side of brown, median area. Genital segments and venter yellow except for small area between intermediate and posterior coxae. Base of antennae, all acetabulae, all coxae, and all trochanters yellow. Anterior femur yellow for basal four fifths; base of anterior tibia yellow beneath. Intermediate femur yellow beneath for almost its entire length. Posterior femur yellow with exception of brown stripe on dorsal surface. Posterior tibia yellow beneath on basal half.

Structural characteristics: Pronotum of apterous forms covers mesonotum. Dorsum of abdomen of apterous female tapers evenly to apex. Posterior tibia without sickle-shaped spur at apex. *Apterous male:* anterior trochanter unarmed. Anterior tibia not dilate, only slightly excavate on apical one third. Pronotum wider than long (L. 77, W. 87); rounded behind. Metanotum short on midline (L. 5, W. 90). Proportions of antennae: Seg. I: II: III: IV:: 74: 44: 39: 39; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 140: 100: 40: 64; of posterior legs: 145: 120: 12: 28. Venter with prominent median carina extending to last segment. Venter distinctly impressed on each side of median carina. Minute, black conical setae on base of jugum of head, proepisternum, mesosternum and along posterior margin of last abdominal segment at sides. Posterior femur greatly incrassate (L. 145, W. 50); armed after basal one third with four irregular rows of spines with three anterior rows all small and approximately same size, posterior row larger with three widely-spaced spines before apical third and one closely-set row on apical one third with one or two spines larger. Posterior tibia curved inward to middle and curved outwards from there to apex; slightly laterally flattened; armed with small teeth within with last two or three teeth enlarged; armed with stout spur at apex. Apterous female: pronotum broadly rounded behind (L. 79, W. 96); metanotum as in male. Proportions of antennae: 68: 40: 35: 35; of intermediate legs: 133: 95: 43: 60; of posterior legs: 125: 112: 11: 28. Venter with faint median carina becoming evanescent on next to last segment. Minute, conical, black setae as in apterous male. Posterior trochanter unarmed. Posterior femur not as incrassate as in male (L. 125, W. 35); armed before middle with one long spine, followed by row of approximately seven smaller, subequal spines to apex, also armed with an anterior, quite irregular row of approximately five small spines on apical one third. Posterior tibia slightly arcuate; armed within with small, subequal teeth with apical one somewhat enlarged; also armed at apex with straight spur. *Winged forms:* proportions and armature similar to apterous forms. *Winged male:* pronotum sharply pointed at apex (L. 125, W. 118); not produced into spiniform process. *Winged female:* pronotum formed same as in apterous male.

Comparative notes: This species may resemble *Rhagovelia panda* Drake and Harris of which there are no specimens in the University of Kansas collections. Unfortunately the type material is in the personal collection of Dr. C. J. Drake and not available for study.

The antennal proportions of *R. horrida* sp. nov. differ from those of *R. panda* Drake and Harris as given in the original description, as well as the unusual color variations on the vertex of the head and the apex of the pronotum. The original description of *R. panda* Drake and Harris is not sufficiently detailed to determine its relationship with *R. horrida* sp. nov. This species is also close to *R. varipes* Champion, but can be separated from *R. varipes* Champion by the differences in the armature of the posterior femur. The males of *R. varipes* Champion and *R. horrida* sp. nov. may be separated by the two larger teeth at the apex of the posterior tibia, and by the ventral carina extending to the last abdominal segment in *R. horrida* sp. nov. The clasper of the male also sets the two apart readily.

Data on types: Holotype, apterous male; allotype, apterous female; holomorphotype winged male, allomorphotype, winged female; paratypes, 1 apterous male, 1 apterous female; paramorphotypes, 2 winged males, 6 winged females. The apterous males were captured at Hda La Libertad, Chiapas, Mexico, Sept. 1, 1937, by H. D. Thomas. The apterous females were captured at Guadalupe, Chiapas, Mexico, 1-15-38, 800 m.a.s.l., Octavio Utrilla L. The morphotype series was captured at Rincón, Guerrero, Mexico, kil. 360 s. Mex. City, 10-31-36, H. D. Thomas. All type specimens are in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on distribution: In addition to the three localities mentioned in the discussion under "Data on types", material from the following localities has been examined:

Mexico: *Chiapas:* Comitan, 1-18-36, 1800 m.a.s.l., Octavio Utrilla L., 1 winged male.

Guatemala: Sta. Lucia, 31-Jan.-05 (J. R. de la Torre-Bueno Collection), 1 apterous male; Agua Caliente, 9-Feb.-05 (J. R. de la Torre-Bueno Collection), 2 apterous females.

Rhagovelia jubata Bacon

(Pl. V, fig. 6)

1948. *Rhagovelia jubata* Bacon, Jour. Kansas Ent. Soc., vol. 21, p. 78.

Size:	*Length*	*Width*
	4.55 mm. apterous male	1.49 mm. apterous male
	4.53 mm. apterous female	1.52 mm. apterous female
	4.72 mm. winged female	1.66 mm. winged female

Color: General color red-brown, clothed with golden pubescence. Pronotum with yellow band on anterior portion becoming pruinose behind eyes. Pronotum slightly lighter in shade than metanotum. Connexivum broadly yellow. Venter dark gray; venter of last abdominal segment and genital segments of male brown with median yellow area. Basal portion of first antennal segment, margins of all acetabulae, all coxae, bases of anterior and posterior trochanters, bases of anterior and posterior femora yellow. In addition anterior femur marked with yellow line running full length of ventral surface, also posterior femur conspicuously striped with anterior and posterior-ventral surfaces yellow for their full length. The dorsum of fifth abdominal segment of female darker than other abdominal segments.

Structural characteristics: Pronotum of apterous forms covering mesonotum. Dorsum of abdomen of apterous female tapers evenly to apex. Posterior tibia without sickle-shaped spur at apex. *Apterous male:* anterior trochanter unarmed. Anterior tibia flattened within for apical one third; not dilate. Pronotum wider than long (L. 68, W. 85); metanotum much wider than long (L. 10, W. 95). Proportions of antennae: Seg. I: II: III: IV:: 84: 47: 44: 42; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 175: 30: 48: 64; of posterior legs: 152: 136: 8: 26. Abdomen tapers evenly to apex. Connexiva semivertical. Dorsum with scattered long hairs. Venter with median carina thickly-set with long hairs; ventral carina extending to last abdominal segment. Minute, black, conical setae on base of jugum of head, proepisternum, and in patch at side of last abdominal segment. Venter of last abdominal segment somewhat excavate on posterior one half. Posterior trochanter armed with one to several very short, and one to three longer teeth. Posterior femur greatly incrassate (L. 150, W. 50); armed on basal one third with row of very small teeth ending in one long spine, followed by two irregular rows of about seven smaller spines to apex. Posterior tibia slightly arcuate; armed within with subequal teeth except for apical tooth which is elongate and in apposition to longer teeth on trochanter; armed at apex with long spur. *Apterous female:* pronotal proportions same as in male. Abdomen gradually tapers posteriorly. Connexiva flat. Proportions of antennae: 75: 45: 43: 39; of intermediate legs: 155: 111: 46: 64; of posterior legs: 135: 117: 8: 26. Minute, black, conical setae as in male. Posterior trochanter unarmed; posterior femur moderately incrassate (L. 135, W. 35) and armed with from none to four very small teeth and one small spine on basal one third, then at middle with one large spine and two irregular rows of approximately seven smaller spines to apex. Posterior tibia very slightly arcuate and armed with equal teeth with elongate spine at apex. *Winged female:* proportions and armature similar to apterous female. Apex of pronotum set with long dark hairs; not produced into a spiniform process. *Winged male:* unknown.

Comparative notes: This species resembles *R. palea* sp. nov. *R. jubata* Bacon can be separated from *R. palea* sp. nov. by the color of the legs which are dark brown to black in *R. jubata* Bacon with conspicuous stripes of yellow on the anterior and posterior femora while the legs of *R. palea* sp. nov. are yellow-brown. The venter of *R. jubata* Bacon is brown-black, while the venter of *R. palea* sp. nov. is light yellow-brown. The posterior femora of all forms are also quite different in armature.

Data on types: Holotype, apterous male; allotype, apterous female; allomorphotype, winged female; paratypes, 40 apterous males, 24 apterous females. Described from specimens from Aguaitia Dept. Loreto, Perú, collected by F. Woytkowski, Oct. 1, 1946. All type specimens are in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on distribution: In addition to the type series, specimens from the following localities have been examined:

Peru: Loreto Dept., Aguaitia, IX- 19-46, F. Woytkowski, 17 apterous males, 13 apterous females, 2 nymphs; Loreto Dept., Roqueron del Padre, Abad Cordillern, VIII-3-46, F. Woytkowski, 1 apterous male; Loreto Dept., Santa Elena, Roqueron Padre, Abad, VIII-8-46, F. Woytkowski, 2 apterous males, 1 apterous female.

Rhagovelia nitida Bacon

(Pl. V, fig. 7)

1948. *Rhagovelia nitida* Bacon, Jour. Kansas Ent. Soc., vol. 21, p. 79.

Size:	*Length*	*Width*
	4.39 mm. apterous male	1.49 mm. apterous male
	4.39 mm. apterous female	1.49 mm. apterous female
	4.52 mm. winged male	1.82 mm. winged male
	4.62 mm. winged female	1.80 mm. winged female

Color: General color brown, with prominent yellow markings, clothed with short golden pubescence. Pronotum tan with uninterrupted yellow band on anterior one fourth; slightly lighter line running longitudinally down middle of pronotum. Metanotum and dorsum of first abdominal segment darker than pronotum. Remainder of dorsum of abdomen tan to yellow with narrow darker areas at juncture of each of segments. Venter, antennae, and genital segments practically unicolorous; legs slightly darker. Posterior femur slightly lighter at base and for three fourths its length ventrally. Wings red-brown; veins darker, not prominent.

Structural characteristics: Pronotum of apterous forms covers mesonotum. Dorsum of abdomen of apterous female tapers evenly to apex. Posterior tibia without sickle-shaped spur at apex. *Apterous male:* anterior trochanter unarmed. Anterior tibia not dilate; slightly excavate on apical third. Pronotum wider than long (L. 75, W. 90); metanotum much wider than long (L. 10, W. 94). Proportions of antennae: Seg. I: II: III: IV:: 77: 49: 52: 44; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 150: 117: 45: 60; of posterior legs: 150: 163: 15: 30. Angle of taper of connexiva increased for last three segments. Ventral carina sharply elevated between coxae of posterior legs with depression on each side, becoming evanescent on fourth segment. Genital segments usually retracted partially into last abdominal segment on at least some specimens. Posterior trochanter thickly set with long hairs; unarmed. Posterior femur greatly incrassate (L. 150, W. 57); ventral surface flattened and beset on basal one third with long hairs; armed on basal half with three irregular rows of small, dark teeth and one long stout isolated spine on posterior margin of ventral surface of leg slightly beyond basal third, armed on apical half of femur with approximately six small, stout spines set in two irregular rows. Posterior tibia slightly arcuate; armed within with two rows of black teeth, teeth at apical three fourths tending to be slightly enlarged; armed at apex with brown spur. *Apterous female:* anterior tibia formed as in apterous male. Pronotum wider than long (L. 70, W. 90); metanotum much wider than long (L. 7, W. 92). Proportions of antennae: 70: 44: 45: 43; of intermediate legs: 130: 108: 42: 58; of posterior legs: 112: 147: 11: 26. Dorsum of abdomen tapering evenly to apex. Connexiva semivertical. Genital segments small. Posterior trochanter unarmed. Posterior femur only moderately incrassate (L. 112, W. 24) and armed at apical one third with one small spine followed by three decreasing spines to apex. Posterior tibia seemingly unarmed. *Winged forms:* proportions and armature similar to apterous forms. Pronotum not produced into spiniform process.

Comparative notes: This species resembles *R. sinuata* Gould. *R. nitida* Bacon can be separated from *R. sinuata* Gould by the unarmed posterior trochanter of the male and the unarmed posterior tibia of the female. The male clasper is quite distinctive and easily sets *R. nitida* Bacon apart from all other closely related species.

Data on types: Holotype, apterous male; allotype apterous female; holomorphotype, winged male; allomorphotype, winged female; paratypes, 4 apterous males, 3 apterous females; paramorphotypes, 3 winged females. Described from Jamaica, B. W. I. All type specimens are in the University of Kansas Collections.

Data on distribution: In addition to the type series, specimens from the following localities have been examined:

BRITISH WEST INDIES: *Jamaica:* St. Andres, Shooters Hill, e. 1800 ft., 3-xii-46, G. B. Thompson, 1 winged female; St. Thomas, XI-14-46, G. B. Thompson, 2 apterous males, 1 apterous female, 4 nymphs; St. Andreas, IV-17-47, G. B. Thompson, 7 apterous males, 8 apterous females, 15 nymphs.

Rhagovelia ornata Bacon

(Pl. V, fig. 8)

1948. *Rhagovelia ornata* Bacon, Jour. Kansas Ent. Soc., vol. 21, p. 80.

Size:	*Length*	*Width*
	5.98 mm. apterous male	1.63 mm. apterous male
	6.00 mm. apterous female	1.63 mm. apterous female

Color: General color red-brown; practically unicolorous. Last two segments of antennae and last tarsal segments of intermediate legs darker brown. Pronotum without lighter band at anterior margin.

Structural characteristics: Pronotum of apterous forms covers mesonotum. Dorsum of abdomen of apterous female tapers evenly to apex. Posterior tibia without sickle-shaped spur at apex. *Apterous male:* anterior trochanter unarmed. Anterior tibia not dilate, slightly flattened on apical one fifth. Pronotum wider than long (L. 90, W. 103); metanotum much wider than long (L. 11, W. 115). Proportions of antennae: Seg. I: II: III: IV:: 107: 55: 56: 55; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 200: 150: 62: 75; of posterior legs: 192: 178: 41: 20. Margins of connexiva taper slightly to last two segments which have an increased angle of taper. Ventral carina pronounced between posterior coxae where segment is depressed on each side, becoming evanescent on next to last segment. Posterior trochanter armed with approximately twelve small, knoblike teeth. Posterior femur greatly incrassate (L. 192, W. 62) on most specimens; armed on basal half with one row of approximately eighteen equally spaced spines which are graduated in size from small teeth on basal area to small spines at middle. The apical half of femur is armed with one isolated larger spine on posterior margin at apical third in those specimens on which posterior femur is greatly incrassate. This isolated spine is not conspicuous in specimens with only moderately incrassate posterior femora. Also with two smaller rows of spines, the posterior row consisting of seven spines and the anterior row of six spines decreasing in size to apex. None of spines of posterior femur greatly enlarged. Posterior tibia curved inward at first and outward beyond apical one third; armed with two rows of small teeth, with one stout, greatly enlarged tooth at apical one third followed by two slightly enlarged and several smaller teeth; armed with stout spur at apex. *Apterous female:* anterior tibia not dilate, slightly flattened on apical one fourth. Proportions of antennae: 100: 51: 55: 50; of intermediate legs: 185: 140: 57: 73; of posterior legs: 160: 176: 18: 36. Abdomen with only slight taper from base to apex. Ventral carina distinct on basal segments, becoming evanescent on last three abdominal segments. Posterior trochanter armed with approximately two small dark teeth. Posterior femur only slightly incrassate (L. 160, W. 30) and armed at apical one third with one small spine followed by four or five smaller, rapidly decreasing spines to apex. Posterior tibia straight; armed on basal half with several small teeth; armed with spur at apex. *Winged forms:* unknown.

Comparative notes: This species resembles *R. robusta* Gould. The males of *R. ornata* sp. nov. can be separated from those of *R. robusta* Gould by the location of the enlarged spine of the posterior tibia which is at the apical one third in *R. ornata* sp. nov. while the enlarged spine of the posterior tibia of *R. robusta* Gould is at the apical one fifth. The females can be separated by the armature of the posterior femur which has the long spine after the apical one third in *R. ornata* sp. nov. while the long spine of the posterior femur of *R. robusta* Gould is at the middle. The absence of minute, conical, black setae on the lower margin of the jugum will set *R. ornata* sp. nov. apart from the other species which it resembles, *R. crassipes* Champion and *R. varipes* Champion.

Data on types: Holotype, apterous male; allotype, apterous female; paratypes, 32 apterous males, 59 apterous females. Described from series collected in Bolivia, Miguelito, May, 1938, A. M. Olalla. All type specimens are in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on distribution: Known only from the type series.

Rhagovelia palea sp. nov.

(Pl. V, fig. 9)

Size:	*Length*	*Width*
	4.05 mm. apterous male	1.21 mm. apterous male
	4.26 mm. apterous female	1.42 mm. apterous female
	4.31 mm. winged male	1.60 mm. winged male
	4.66 mm. winged female	1.74 mm. winged female

Color: General color yellow-brown. The anterior margin of pronotum yellow behind vertex of head becoming pruinose behind eyes. Head and pronotum tan in apterous forms; posterior portion of pronotum tan in winged forms. Venter yellow-brown. Base of anterior femora, base of first antennal segments, all coxae and trochanters yellow-white. Metanotum and dorsum of abdominal segments red-brown. Wings brown, veins prominent, anterior basal cell of wing pruinose.

Structural characteristics: Pronotum of apterous forms covers mesonotum. Dorsum of abdomen of apterous female tapers evenly to apex. Posterior tibia without sickle-shaped spur at apex. *Apterous male:* anterior trochanter unarmed; anterior tibia slightly dilate, flattened on apical one third. Pronotum wider than long (L. 57, W. 76); metanotum much wider than long (L. 12, W. 80). Proportions of antennae: Seg. I: II: III: IV:: 70: 39: 40: 38; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 145: 105: 40: 53; of posterior legs: 117: 104: 9: 24. Connexiva tapers to apex, angle of taper increasing for last three segments. Inconspicuous, hairy ventral carina extending to last abdominal segment. Minute conical, black setae on proepisternum and in patch on side of last abdominal segment. Posterior trochanter armed with from two to six very small teeth and one larger tooth. Posterior femur moderately incrassate (L. 117, W. 35); armed on basal two fifths with one row of small, black, knoblike teeth, from basal two fifths to apex with two rows of spines. The anterior row of spines begins just before middle with one long spine followed by eight to ten smaller, subequal spines; the posterior row begins after middle with one long spine displaced toward posterior margin, then with approximately six gradually decreasing spines to apex. Posterior tibia slightly arcuate; armed with two rows of teeth with apical tooth usually noticeably enlarged; armed at apex with prominent spur. *Apterous female:* pronotum and metanotum formed much as in male. Proportions of antennae: 70: 39: 37: 37; of intermediate legs: 135: 104: 40: 55; of posterior legs: 117: 100: 8: 24. Posterior trochanter unarmed, or may be armed with one tooth in some specimens. Posterior femur moderately incrassate (L. 117, W. 30) and armed with one long spine at middle followed by five or six decreasing spines to apex. Posterior tibia very slightly arcuate; armed with two rows of equal teeth and stout spur at the apex. Dorsum of first abdominal segment thickly beset with dark hairs on posterior portion. *Winged forms:* proportions and armature same as for apterous forms. Tip of pronotum in both sexes thickly beset with long dark hairs. Pronotum not produced into a spiniform process. Wings just covering apex of genital segments.

Comparative notes: This species resembles *R. jubata* Bacon. *R. palea* sp. nov. can be separated from *R. jubata* Bacon by the light yellow-brown venter and yellow-brown legs of all forms. The armature of the posterior femur of all forms is also quite distinct for each of the two species.

Data on types: Holotype, apterous male; allotype, apterous female; holomorphotype, winged male; allomorphotype, winged female; paratypes, 12 apterous males, 11 apterous females; paramorphotypes, 2 winged females. Described from series labeled: "Perú, Dept. Ayacucho, Prov. La Mar, Sivia, Jungle 790 m. a. s. l., Bks. Apurimac riv., June 15-28-1941, F. Woytkowski, No. 4212." All type specimens are in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on distribution: In addition to the type series, specimens from the following localities have been examined:

BOLIVIA: Road between Tedos Santos and Palmer, R. Chapare, March, 1938, A. M. Olalla, 10 apterous males, 12 apterous females; R. Beni Cachuela, Esperanza, 9-37, A. M. Olalla, 2 apterous males, 1 winged male, 1 winged female.

PERU: Dept. Ayacucho, Prov. La Mar, Sivia, jungle, 790 m.a.s.l., stagnant pools, June 24-30, 1941, F. Woytkowski, No. 426, 3 apterous males, 1 apterous female; Dept. Ayacucho, Prov. La Mar, Sivia, jungle, 790 m.a.s.l., stagnant boggy pools, June 18-19, 1941, F. Woytkowski, No. 428, 1 apterous male, 2 apterous females; Dept. Ayacucho, Prov. La Mar, Sivia, jungle brooks, 790 m.a.s.l., June 24-30, 1941, F. Woytkowski, No. 425, 3 apterous males; Vic. San Pedro, 90 m.a.s.l., pools and ponds, May 15-19, 1935, F. Woytkowski, 2 apterous males, 3 apterous females; Vic. San Pedro, 900 m.a.s.l., pools in jungle, May 15-29, 1935, F. Woytkowski, 3 apterous males, 1 winged male, 4 apterous females; Vic. Sani Beni, 840 m.a.s.l., tiny brook in open land, Oct. 31, 1935, F. Woytkowski, 2 apterous males, 2 apterous females; Vic. Sani Beni, 840 m.a.s.l., brooks and pools of Sani Beni, Aug. 31, 1935, F. Woytkowski, Field

Note 3560, 1 apterous male, 2 apterous females; Vic. Sani Beni, 840 m.a.s.l., brook on open cultivated land, Oct. 12, 1935, F. Woytkowski, Field Note 3566, 3 apterous males, 3 apterous females; Vic. Río Negro, 790 m.a.s.l., River R. Negro, Nov. 4, 1935, F. Woytkowski, Field Note 3550, 3 apterous males, 1 winged male, 5 apterous females; Vic. Río Negro, 790 m.a.s.l., shady jungle brook, bed of clay, Oct. 29, 1935, F. Woytkowski, Field Note 3564, 2 apterous males, 5 apterous females; Vic. Río Negro, 790 m.a.s.l., in R. Negro, Nov., 1935, F. Woytkowski, Field Note 3553e, 5 apterous males, 1 apterous female; Dept. Huánuca, Vic. of Afilador, jungle, 800 m.a.s.l., June 3-7, 1937, F. Woytkowski, No. 3765, 7 apterous males, 7 apterous females; Aguaitia, Dept. Loreto, Sept. 1, 1946, F. Woytkowski, 9 apterous males, 5 apterous females; Aguaitia Dept. Loreto, Sept. 19, 1946, F. Woytkowski, 3 apterous males, 1 winged male, 5 apterous females; Satipo, Nov., 1942, Pedro Paprzycki, 3 winged males, 2 apterous females, 2 winged females; Satipo, Dec., 1942, Pedro Paprzycki, 36 apterous males, 18 winged males, 27 apterous females, 13 winged females.

Rhagovelia panda Drake and Harris

1935. *Rhagovelia panda* Drake and Harris, Proc. Biol. Soc. Washington, vol. 48, p. 193.

This species is not represented in the material in the Francis Huntington Snow Entomological Collections, University of Kansas. The original description is quoted below:

"Moderately large, blackish, thickly clothed with golden pubescence. Antennal formula, 54: 34: 30: 26; first and second segments with a few bristly hairs, the first with basal half yellowish. Rostrum extending on basal portion of mesosternum.

"*Apterous form.*—Pronotum long, indistinctly carinate, broadly rounded behind; in front broadly yellowish.

"*Winged form.*—Pronotum broadly yellowish in front as in apterous form, indistinctly carinate, triangularly produced behind, the humeri prominent.

"*Male.*—Hind femora strongly developed, in some individuals enormously enlarged, armed beneath with numerous irregularly placed, black teeth of various sizes. Coxae and trochanters, the femora beneath and base and sides within yellowish white. Intermediate tarsi with segment three longer than two (35: 47). Hind tibia nearly straight or strongly curved, denticulate beneath, armed at apex with straight spur and before apex usually with three large, stout teeth. Connexiva yellowish white, the narrow margin and the broad basal stripe above blackish. Venter with a very prominent median carina extending to last segment, distinctly impressed on each side of carina; last segment yellowish, scarcely excavated behind. Clasper long, narrow, slightly curved, faintly narrowed towards apex.

"*Female.*—Color markings about as in male. Hind femora moderately swollen, with a large curved tooth just before middle, thence to apex with two rows of shorter black teeth; hind tibia nearly straight, finely denticulated.

"Length, 4.90-6.00 mm.; width, 2.00 mm.

"*Holotype,* apterous male; *allotype,* winged female, and *paratypes,* several apterous and macropterous males and females, Chiquimula, Guatemala, June, 1930; authors' collection.

"The authors desire to express their appreciation to Mr. W. E. China of the British Museum for comparing this species with the type of *R. femoralis* Champion. The clasper is longer and narrower at the base than in *femoralis.* The last segment of the intermediate tarsi is slightly longer than the second. The venter, in some specimens, is mostly yellowish, also the coxae and trochanters. The hind trochanters are armed with two or three short teeth in the male."

Comparative notes: This species resembles *R. horrida* sp. nov. As there are no specimens of *R. panda* Drake and Harris available for study it has been necessary to attempt to determine this species by the original description. There are differences in color pattern and significant proportional differences in the antennae, which in *R. horrida* sp. nov. are formed with the last two segments equal in length while in *R. panda* Drake and Harris segment IV is definitely shorter than III. It has been thought best to consider these two separate species. A fresh evaluation of these two species can be made when Dr. Drake's type material which is in his personal collection becomes available for study.

Rhagovelia perfidiosa Bacon

(Pl. V, fig. 10)

1948. *Rhagovelia perfidiosa* Bacon, Jour. Kansas Ent. Soc., vol. 21, p. 81.

Size:	*Length*	*Width*
	2.98 mm. apterous male	1.16 mm. apterous male
	3.32 mm. apterous female	1.33 mm. apterous female
	3.52 mm. winged male	1.46 mm. winged male
	3.52 mm. winged female	1.50 mm. winged female

Color: General color brown, clothed with golden pubescence. Pronotum with yellow band on anterior one fifth, becoming pruinose behind eyes; posterior lateral margins and median longitudinal line orange. Dorsum of first abdominal segment blue-gray except for median dark brown area; fourth and fifth abdominal segments blue-gray with smaller median dark brown areas; sixth abdominal segment brown with yellow median area; seventh abdominal segment and genital segments yellow. Connexiva broadly yellow. Venter blue-gray. Venter of last abdominal segment and genital segments yellow. Base of antennae, margins of all acetabulae, all coxae and trochanters, base of anterior and posterior femora, and total length of dorsal and ventral surfaces of intermediate and posterior femora yellow. Basal half of wings lighter than apical half. Anterior basal cell of wing pruinose.

Structural characteristics: Pronotum of apterous forms covers mesonotum. Dorsum of abdomen of apterous female tapers evenly to apex. Posterior tibia without sickle-shaped spur to apex. *Apterous male:* anterior trochanter unarmed. Anterior tibia slightly dilate and flattened within on apical one half. Pronotum wider than long (L. 50, W. 67); metanotum much wider than long (L. 7, W. 57). Proportions of antennae: Seg. I: II: III: IV:: 50: 29: 29: 30; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 110: 80: 29: 47; of posterior legs: 88: 78: 4: 18. Abdomen tapers more sharply to apex on last three segments. Venter without median carina. Minute, conical, black setae on base of jugum of head, and on proepisternum. Posterior trochanter armed with from one to nine very small knoblike teeth with one larger tooth near apex. Posterior femur greatly incrassate (L. 88, W. 30). Armed on basal one third with a row of small teeth; after basal one third with two irregular rows of spines. The anterior row of spines begins at basal one third with one long spine followed by three smaller spines followed by another long spine offset toward anterior margin and three smaller spines to apex. The posterior row begins approximately at middle with one large spine followed by four decreasing spines to apex. Posterior tibia slightly arcuate and armed with two rows of equal teeth throughout; armed at apex with a long stout spur. *Apterous female:* proportions of antennae: 55: 28: 30: 30; of intermediate legs: 110: 83: 34: 51; of posterior legs: 92: 80: 5: 22. Abdomen tapers evenly to apex. No median ventral carina. Minute, black, conical setae as in male. Posterior trochanter unarmed. Posterior femur greatly incrassate (L. 92, W. 30) and armed just before middle with one long spine followed by approximately five smaller spines to apex; also armed with row of four small, equal spines on anterior margin of ventral surface beginning at apical one third and continuing to apex. Posterior tibia slightly arcuate and armed with two rows of teeth that decrease in size to apex; apex armed with long, stout spur. *Winged forms:* Proportions and armature same as for apterous forms. Apex of pronotum thickly beset with long, dark hairs; not continued into a spiniform process.

Comparative notes: This species resembles *R. amazonensis* Gould and *R. williamsi* Gould. *R. perfidiosa* Bacon can be separated from either of these species by the presence of the minute, conical, black setae on the inner portion of the proepisternum of all forms. The armature of the posterior femur is distinct from either of the above mentioned species, as is the clasper of the male genitalia.

Data on types: Holotype, apterous male; allotype, apterous female; holomorphotype, winged male; allomorphotype, winged female; paratypes, 81 apterous males, 85 apterous females; paramorphotypes, 5 winged males, 14 winged females. Described from a series collected in Brazil, A. M. Olalla, No. 379. All type specimens are in the Francis Huntington Snow Entomologist Collections, University of Kansas.

Data on distribution: In addition to the type series, specimens from the following localities have been examined:

BRAZIL: Rio Negro, Manáos Region, Oct., 1935, A. M. Olalla, 3 apterous males, 2 winged males, 7 apterous females; Rio Purús, Castanha Region, A. M. Olalla, Sept., 1935, 1 winged female; Vic. João Pesson (São Phelipe), River Juruá, 7-10-, 9-20-36, A. M. Olalla, No. 375, 21 apterous males, 1 winged male, 24 apterous females, 2 winged females; State of Pará, Lago Grande, Feb. '39, A. M. Olalla, 19 apterous males, 27 apterous females.

Rhagovelia relicta Gould

(Pl. V, fig. 11)

1931. *Rhagovelia relicta* Gould, Kansas Univ. Sci. Bull. vol. 20, p. 39.
1935. *Rhagovelia relicta* Drake and Harris, Proc. Biol. Soc. Washington, vol. 48, p. 36 (record color variations).

Size:	*Length*	*Width*
	3.80 mm. apterous male	1.16 mm. apterous male
	3.85 mm. apterous female	1.33 mm. apterous female

Color: General color black, clothed with golden pubescence. Anterior band of pronotum broadly yellow becoming somewhat pruinose behind eyes. Dorsum of abdomen with median, black, shining spots on last two segments. Margins of connexiva yellow. Venter blue-black to brown-black. Venter of last abdominal segment brown beneath. Base of antennae, margins of all acetabulae, all coxae, anterior and posterior trochanters and prominent stripes on anterior and posterior femora yellow.

Structural characteristics: Pronotum of apterous forms covers mesonotum. Dorsum of abdomen of apterous female tapers evenly to apex. Posterior tibia without sickle-shaped spur at apex. *Apterous male:* anterior trochanter unarmed. Anterior tibia only slightly dilate and flattened within toward apex. Pronotum rather sharply rounded behind (L. 67, W. 75). Metanotum short on midline (L. 4, W. 78). Proportions of antennae: Seg. I: II: III: IV:: 60: 30: —: —; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 121: 90: 33: 55; of posterior legs: 105: 93: 7: 22. Abdomen tapers rather evenly to apex. Connexiva semivertical. Venter without median carina. Venter of last abdominal segment roundly excavate beneath on posterior one half. Minute, black, conical setae on base of jugum of head, and on inner surface of proepisternum. Posterior trochanter armed with from one to three small, subequal teeth. Posterior femur moderately incrassate (L. 105, W. 33); armed on basal one third with one row of small, knoblike teeth; apical two thirds armed with two rows of teeth, the posterior row with one long spine after basal one third followed by two short spines, one long spine somewhat offset to posterior margin, followed by four or five small spines to apex, the anterior row with six to eight small subequal spines in an irregular row beginning after basal one third and continuing to apex. Posterior tibia almost straight; armed within with two rows of subequal teeth with tooth at apical one fifth enlarged; armed at apex with stout spur. *Apterous female:* anterior leg as in male. Pronotum broadly rounded at apex (L. 68, W. 80). Metanotum short on midline (L. 7, W. 84). Proportions of antennae: 60: 32: —: —; of intermediate legs: 115: 85: 35: 56; of posterior legs: 97: 90: 5: 26. Dorsum of abdomen tapers rather evenly to apex. Connexiva vertical. Minute, black, conical setae as in male. Posterior trochanter unarmed. Posterior femur moderately incrassate (L. 97, W. 24); armed beyond middle with one long spine followed by two or three small spines. Posterior tibia straight; armed within with small teeth with those of basal one half stouter; armed at apex with spur. *Winged forms:* unknown.

Comparative notes: This species resembles *R. femoralis* Champion. *R. relicta* Gould can be separated from *R. femoralis* Champion by the nature of the minute, black setae of the proepisternum which are conical in *R. relicta* Gould while being bristlelike and more elongate in *R. femoralis* Champion. *R. relicta* Gould is also related to *R. robusta* Gould. *R. relicta* Gould can be separated from *R. robusta* Gould by the nature of the armature of the posterior femur and the color of the intermediate trochanter which is black in *R. relicta* Gould, yellow in *R. robusta* Gould. Drake and Harris (1935 a; p. 36) record color variations and indicate that *R. relicta* Gould may be identical with *R. robusta* Gould. It has been thought best to consider these two species as distinct until additional specimens will permit a study of the limits of variation.

Data on types: Holotype, apterous male; allotype, apterous female; both collected in Campinas, Estado de São Paulo, Brazil, 3-10-24, by F. X. Williams. These types are in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on distribution: Recorded from Brazil. Represented in the Francis Huntington Snow Entomological Collections only by the type series.

Rhagovelia robusta Gould

(Pl. V, fig. 12)

1931. *Rhagovelia robusta* Gould, Kansas Univ. Sci. Bull., vol. 20, p. 41.
1933. *Rhagovelia robusta* Gould, Ann. Ent. Soc. America, vol. 26, p. 469.
1935. *Rhagovelia sinuata calcaris* Drake and Harris, Proc. Biol. Soc. Washington, vol. 48, p. 36 (describes from Perú).

Size:	*Length*	*Width*
	4.45 mm. apterous male	1.40 mm. apterous male
	4.75 mm. apterous female	1.50 mm. apterous female

Color: General color red-brown varying in shade from light to dark. On dark red-brown specimens anterior band of pronotum yellow as is indefinite median line on disc of pronotum; median spot on dorsum of last abdominal segment brown; margins of connexiva yellow-brown; also base of posterior femur yellow. On lighter red-brown specimens anterior band of pronotum not set off by definite markings; median spot on dorsum of last abdominal segment yellow; margins of connexiva yellow; base of antennae, margins of all acetabulae, all coxae, anterior and posterior trochanters, and base of anterior and posterior femur yellow to white.

Structural characteristics: Pronotum of apterous forms covers mesonotum. Dorsum of abdomen of apterous female tapers evenly to apex. Posterior tibia without sickle-shaped spur at apex. *Apterous male:* anterior trochanter unarmed. Anterior tibia slightly dilate and flattened within. Pronotum rounded behind (L. 73, W. 83). Metanotum short on midline (L. 7, W. 86). Proportions of antennae: Seg. I: II: III: IV:: 75: 42: 43: 37; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 150: 107: 41: 60; of posterior legs: 135: 120: 9: 27. Abdomen tapers slightly at first with angle of taper increasing for last three segments. Connexiva semivertical. Venter of abdomen with more or less distinct median carina extending to last segment. Venter of last abdominal segment roundly excavate on posterior one half beneath. Black, minute, conical setae on base of jugum of head and on inner surface of proepisternum. Posterior trochanter armed with two or three subequal, small teeth. Posterior femur greatly incrassate (L. 135, W. 55); armed on basal one fourth with one row of five or six small teeth; apical three fourths armed with three to five irregular rows of subequal spines; armed near posterior margin of ventral surface just beyond middle with one long spine with three to five smaller spines in rough semicircle on posterior margin of ventral surface of femur. Posterior tibia arcuate, armed within with two rows of teeth with one tooth at approximately apical one seventh greatly enlarged; armed at apex with stout spur. *Apterous female:* anterior leg as in male. Pronotum rounded behind (L. 75, W. 87). Metanotum as in male (L. 6, W. 89). Proportions of antennae: 82: 46: 47: 38; of intermediate legs: 118: 95: 37: 57; of posterior legs: 102: 100: 7: 23. Dorsum of abdomen tapers evenly to apex. Connexiva semivertical. Minute, black, conical setae as in male. Posterior trochanter unarmed. Posterior femur not as incrassate as in male (L. 102, W. 30); armed at middle with one long spine followed by eight or ten smaller, rapidly decreasing spines to apex. Posterior tibia straight; armed within with two rows of small spines with those on basal one half stouter; armed at apex with slender spur. *Winged forms:* unknown.

Comparative notes: This species resembles *R. relicta* Gould. *R. robusta* Gould can be separated from *R. relicta* Gould by the difference in armature of the posterior femur, which in *R. robusta* Gould is more strongly developed and of a different arrangement in both the males and females of the two species. The intermediate trochanter of *R. relicta* Gould is black to dark brown on the specimens at hand while that of *R. robusta* Gould is yellow to orange. There is some variation in incrassateness of the posterior femur, and on those specimens which has a less incrassate posterior femur the armature is reduced but of the same general arrangement. *Rhagovelia sinuata calcaris* Drake and Harris as represented by paratypes in the Francis Huntington Snow Entomological Collections is indistinguishable from *R. robusta* Gould, and the name *R. sinuata calcaris* Drake and Harris becomes a synonym of *R. robusta* Gould.

Data on types: Holotype, apterous male; allotype, apterous female; paratypes, 1 apterous male, 4 apterous females. The above type series is in the Francis Huntington Snow Collections, University of Kansas. Collected in Paraguay.

Data on distribution: In addition to the type series, specimens have been examined from the following localities:

PERU: Vic. Pampa Hermosa, 1600 m.a.s.l., stream pools, May 1-5, 1935, F. Woytkowski, 25 apterous males, 15 apterous females; Río Paucartambo, Quiroz, Dec. 1933 (paratypes of *R. sinuata calcaris* Drake and Harris), 1 apterous male, 1 apterous female; Dept. Huánuco, Vic. Leonpampa, jungle, 800 m.a.s.l., Dec. 11-30, 1937, No. 3811, F. Woytkowski, 8 apterous males, 4 apterous females; bought from Juan D. Rivas, 3 apterous males, 3 apterous females; Vic. San Pedro, 900 m.a.s.l., muddy ponds, May 15-19, 1935, F. Woytkowski, 1 apterous male, 3 apterous females; Vic. Pampa Hermosa, 1600 m.a.s.l., slow muddy brook, May 1-5, 1935, F. Woytkowski, 13 apterous males, 7 apterous females.

Rhagovelia scitula sp. nov.

(Pl. V, fig. 13)

Size:	*Length*	*Width*
	3.83 mm. apterous male	1.20 mm. apterous male
	4.16 mm. apterous female	1.36 mm. apterous female

Color: General color dark brown, covered with golden pubescence. Anterior one fifth of pronotum yellow. Margins of connexiva and spot on dorsum of last three (male) or four (female) abdominal segments yellow-brown. Venter with mesosternum tan, metasternum and first three or four abdominal segments brown-black, remaining segments progressively lighter brown, first genital segment yellow, except at apex, second genital segment brown. Base of antennae, all coxae and trochanters, and bases of anterior and posterior femora yellow when viewed from above; all femora yellow in ventral view.

Structural characteristics: Pronotum of apterous forms covers mesonotum. Dorsum of abdomen of apterous female tapers evenly to apex. Posterior tibia without sickle-shaped spur at apex. *Apterous male:* anterior trochanter unarmed, anterior tibia not dilate, very slightly excavate for anterior half. Pronotum wider than long (L. 65, W. 82) and covering mesonotum. Metanotum (L. 3, W. 80) almost hidden in middle by apex of pronotum. Proportions of antennae: Seg. I: II: III: IV:: 64: 34: —: —; of intermediate legs:

Fem.: Tib.: Tars. II: Tars. III:: 127: 93: 38: 54; of posterior legs: 108: 97: 8: 26. Abdomen tapering evenly to apex. Ventral carina present, becoming evanescent on last two or three abdominal segments. Minute, conical, black setae on jugum of head, proepisternum, mesosternum and venter of abdomen with exception of last segment on which minute setae are concentrated into one row along each side of posterior edge of segment. Posterior trochanter armed with one long spine and two or three very small, knoblike teeth. Posterior femur greatly incrassate (L. 108, W. 37) and flattened beneath. Armed on basal one half with median row of very small, knoblike teeth, apical one half armed with two lateral rows of spines, the anterior row starting just before middle with approximately four small, knoblike teeth followed by one bent, moderate-sized spine just before apex, the posterior row starting at approximately middle with one moderate-sized spine followed by three or four smaller spines increasing in size toward the apex. Posterior tibia arcuate and denticulate within, apical three or four teeth being larger; armed with curved spur at apex. *Apterous female:* pronotum as in male (L. 68, W. 90) covering mesonotum and most of metanotum. Proportions of antennae: 67: 35: 37: 35; of intermediate legs: 125: 94: 37: 55; of posterior legs: 108: 100: 9: 25. Abdomen tapers evenly to apex as in male. Minute, conical, black setae as in male except not as apparent on last abdominal segment at sides. Posterior trochanter unarmed. Posterior femur not as incrassate as in male (L. 108, W. 26); armed on basal one half with one or two small teeth, apical one half armed with two rows of spines, the anterior row begins at apical one fourth and consists of three or four small spines decreasing in size to apex, the posterior row starts just beyond middle with one long, bent spine followed by four or five smaller, decreasing spines to apex. Posterior tibia almost straight and denticulate within, teeth more closely set on basal two thirds; armed at apex with straight spur. *Winged forms:* unknown.

Comparative notes: This species resembles *R. whitei* (Breddin) from which it can be separated by the yellow brown spots on the dorsum of the last three (male) or four (female) abdominal segments in *R. scitula* sp. nov. Also the armature of the posterior femur of both male and female is somewhat different. The posterior tibia of the apterous male of *R. whitei* (Breddin) is flattened and twice curved while that of *R. scitula* sp. nov. is cylindrical and curved inward.

Data on types: Holotype, apterous male; allotype, apterous female; paratypes, 2 apterous males, 4 apterous females. Described from specimens collected in São Paulo, Capital Brazil, 9/XI/40, Kurt. All type specimens are in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on distribution: In addition to the type series specimens from the following localities have been examined:

PERU: Loreto Dept., Aguaitia, IX-19-46, F. Woytkowski, 17 apterous males, 13 apterous females, 2 nymphs; Loreto Dept., Roqueron del Padre, abad Cordillern, VIII-3-46, F. Woytkowski, 1 apterous male; Loreto Dept., Santa Elena, Roqueron Padre, Abad, VIII-8-46, F. Woytkowski, 2 apterous males, 1 apterous female.

Rhagovelia sinuata Gould

(Pl. V, fig. 14)

1931. *Rhagovelia sinuata* Gould, Kansas Univ. Sci. Bull., vol. 20, p. 42.

Size:

Length	*Width*
4.35 mm. apterous male	1.40 mm. apterous male
4.65 mm. apterous female	1.60 mm. apterous female
5.05 mm. winged male	1.76 mm. winged male
5.40 mm. winged female	1.76 mm. winged female

Color: General color red-brown to brown, clothed with golden pubescence. Anterior band of pronotum not well defined, slightly lighter in shade. Venter concolorous with dorsum. Base of antennae, margins of all acetabulae, and all coxae and trochanters yellow-brown. Wings dark brown; anterior, basal cell of wing pruinose.

Structural characteristics: Pronotum of apterous forms covers mesonotum. Dorsum of abdomen of apterous female tapers evenly to apex. Posterior tibia without sickle-shaped spur at apex. *Apterous male:* anterior trochanter unarmed. Anterior tibia not dilate; flattened within on apical one half. Pronotum rounded behind (L. 73, W. 85). Metanotum short on midline (L. 9, W. 89). Proportions of antennae: Seg. I: II: III: IV:: 73: 43: 47: 42; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 140: 120: 40: 56; of posterior legs: 132: 117: 9: 28. Abdomen tapers slightly at first; angle of taper increasing on last two segments. Connexiva semivertical. Venter without definite median carina. Minute, black, conical setae on base of jugum of head, on proepisternum, and on venter of all abdominal segments except last. Venter of last abdominal segment depressed on posterior one half on each side of median line beneath. Posterior trochanter armed with two to four small, subequal teeth. Posterior femur usually strongly incrassate (L. 132, W. 45); armed on basal one third with one row of small knoblike teeth; armed after basal one third with two rows of spines, the posterior row consists of a long spine, followed by four short spines, another long spine and series of shorter spines to apex, the anterior row consists of short subequal widely-spaced spines from basal one third to apex. Posterior tibia arcuate; armed within with two irregular rows of subequal teeth and curved spur at apex. *Apterous female:* anterior leg as in male. Pronotum rounded behind (L. 76, W. 93). Metanotum as in male (L. 10, W. 100). Proportions of antennae: 69: 41: 46: 40; of intermediate legs: 137: 113: 38: 54; of posterior legs: 118: 119: 10: 29. Dorsum of abdomen tapers evenly to apex. Minute, conical, black setae as in male. Posterior trochanter unarmed. Posterior femur less incrassate than in male (L. 118, W. 30); armed beyond middle with one long spine followed by six or eight smaller, decreasing spines to apex; also armed on apical one half with anterior row of small subequal spines. Posterior tibia straight; armed within with two rows of small, subequal teeth; armed at apex with spur. *Winged forms:* proportions and armature similar to apterous forms. Wings extend beyond apex of genital segments. Pronotum formed same in both sexes; not continued into spine at apex.

Comparative notes: This species resembles *R. nitida* Bacon. *R. sinuata* Gould can be separated from *R. nitida* Bacon by the armed posterior trochanter of the male, and the armed posterior tibia of the female. In specimens with a less incrassate posterior femur in the male the armature is reduced but of the same general pattern.

Data on types: Holotype, apterous male; allotype, apterous female; morphotypes, winged male and winged female. Gould states the morphotype is a winged female. In examining the type series only one winged form is present and it is a winged male bearing the label: "Morphotype, *Rhagovelia sinuata* Gould." This winged male is taken to be the holomorphotype and a winged female is established as the allomorphotype. The original type series was collected in Tunguragu Vale, Banos, Ecuador, Jan. 1923, by F. X. Williams. The allomorphotype was collected in Río Blanca, Ecuador, 1800 m.a.s.l., May, 1936, by Clarke-MacIntyre. All type specimens are in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on distribution: Recorded only from Ecuador. In addition to the type series, specimens from the following localities have been examined (new distribution record for major political areas is indicated with an asterisk):

ECUADOR: Río Blanco, swift river, April, 1936, Clarke-MacIntyre, No. 3622, 35 apterous males, 27 apterous females; Río Blanco, running stream, May, 1936, Clarke-MacIntyre, No. 3686, 18 apterous males, 1 winged male, 12 apterous females; Juangolo Creek, Banos, March 15, 1936, Clarke-MacIntyre, No. 3618, 7 apterous males, 12 apterous females; Río Blanco, 1800 m.a.s.l., May, 1936, Clarke-MacIntyre, No. 3683, 27 apterous males, 3 winged males, 26 apterous females, 2 winged females; Mera, 1000 m.a.s.l., Nov. 5, 1936, Clarke-MacIntyre, No. 3684, 3 apterous males, 12 apterous females.

PERU: Vic. Rioja, Dept. San Martín, jungle, 900 m.a.s.l., Sept. 9, 1936, F. Woytkowski, No. 3682, 10 apterous males, 14 apterous females, 1 winged female.

Rhagovelia varipes Champion

(Pl. V, fig. 15)

1898. *Rhagovelia varipes* Champion, Biol. Centr. Amer., Het., vol. 2, p. 133.
1901. *Rhagovelia varipes*, Kirkaldy, Ent., vol. 34, p. 308.
1931. *Rhagovelia beameri* Gould, Kansas Univ. Sci. Bull., vol. 20, p. 18 (describes from Arizona).
1931. *Rhagovelia varipes*, Gould, Kansas Univ. Sci. Bull., vol. 20, p. 46.
1936. *Rhagovelia varipes*, Drake and Harris, Proc. Biol. Soc. Washington, vol. 49, p. 106 (places *R. beameri* Gould as a synonym of *R. varipes* Champion).

Size:	*Length*	*Width*
	5.70 mm. apterous male	1.66 mm. apterous male
	6.45 mm. apterous female	1.92 mm. apterous female
	6.52 mm. winged male	2.25 mm. winged male
	6.40 mm. winged female	2.30 mm. winged female

Color: General color black, clothed with golden pubescence. Anterior band of pronotum orange behind vertex of head, becoming black behind eyes. Margins of connexiva orange. Dorsum of last one or two abdominal segments with median shining brown areas. Venter blue-gray at base becoming red-brown to brown for last four or five segments. Base of antennae, margins of anterior and posterior acetabulae, all coxae, all trochanters (intermediate pair only in part), and anterior and posterior femora beneath orange to red-brown.

Structural characteristics: Pronotum of apterous forms covers mesonotum. Dorsum of abdomen of apterous female tapers evenly to apex. Posterior tibia without sickle-shaped spur at apex. *Apterous male:* anterior trochanter unarmed. Anterior tibia flattened within; not dilate. Pronotum rounded behind (L. 91, W. 110).

Metanotum short on midline (L. 6, W. 105). Proportions of antennae: Seg. I: II: III: IV:: 95: 48: 60: 52; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 170: 140: 58: 68; of posterior legs: 163: 176: 20: 35. Abdomen tapers only slightly to apex. Connexiva semivertical. Venter with median carina on basal three or four segments. Minute black conical setae on base of jugum of head, proepisternum, and along venter of abdomen except for last abdominal segment where conical setae are thinly scattered along posterior margin of venter of last abdominal segment at sides. Posterior trochanter armed with five to nine small subequal teeth. Posterior femur strongly incrassate (L. 163, W. 54); armed with two rows of spines, the posterior row begins near base with small, gradually increasing spines with three longer spines near middle followed by smaller increasing spines with another long spine at apical one third followed by two or three much smaller spines to apex, the anterior row composed of irregularly placed, small, subequal spines beginning near base and continuing to apex. Posterior tibia slightly arcuate; armed within with two rows of teeth with those on apical one third longer and stronger; armed at apex with small, blunt spur. *Apterous female:* anterior legs as in male. Pronotum broadly rounded behind (L. 104, W. 116). Metanotum short on midline (L. 4, W. 116). Proportions of antennae: 93: 52: 64: 52; of intermediate legs: 173: 144: 62: 74; of posterior legs: 160: 186: 21: 38. Dorsum of abdomen tapers evenly to apex. Connexiva semivertical. Minute, black, conical setae as in male, except not apparent on posterior margin of venter of last abdominal segment. Posterior trochanter unarmed. Posterior femur not as incrassate as in male (L. 160, W. 33); armed on apical one half with one row of spines consisting of an increasing series of four small spines then one somewhat larger spine at apical one third followed by four or five small, rapidly decreasing spines to apex; on some specimens with reduced armature apparently only armed on apical one third. Posterior tibia straight and apparently unarmed. *Winged forms:* proportions and armature similar to apterous forms. Pronotum not produced into spiniform process at apex in either sex.

Comparative notes: This species resembles *R. crassipes* Champion. *R. varipes* Champion can be separated from *R. crassipes* Champion by the lack of the abruptly larger tooth at the apical one third of the posterior tibia of the male; by having only two or three rows of spines on the posterior femur of the male; and by the posterior femur of the female being armed at the apical one third with the longest spine, while the longest spine of the posterior femur of the female of *R. crassipes* Champion is placed near the middle.

Data on types: Champion's type is an apterous male collected in Bilimek, Mexico. The type specimen is in the Vienna Museum.

Data on distribution: Recorded from Arizona, New Mexico, and Mexico. Specimens have been examined from the following localities:

MEXICO: *México:* Real de Arriba, Dist. of Temascaltepec, Alt. 1960 meters, May-June, 1933, H. E. Hinton, 13 winged males, 15 winged females.

Hidalgo: San Antonio, near El Salto, 5000 ft. a.s.l., semitropical, June 10, 1937, Meldon Embury, 20 apterous males, 2 apterous females, 17 winged males.

UNITED STATES: *Arizona:* Chiricahua Mts., 7-8-32, R. H. Beamer, 9 apterous males; Cochise Co., 7-29-27, R. H. Beamer (type series of *R. beameri* Gould), 17 apterous males, 1 winged male, 50 apterous females, 2 winged females; Ramsay Co., VII-30-41, B. Hodgden, 12 apterous males, 17 apterous females; Huachuca, 5-30-37, W. Benedict, 9 apterous males, 11 apterous females; Huachuca Mts., 7-8-32, R. H. Beamer, 6 apterous males, 2 winged males, 13 apterous females, 2 winged females.

Rhagovelia whitei (Breddin)

(Pl. V, fig. 16)

1898. *Neovelia whitei* Breddin, Jahrb. Nat. Ver. zu Magee, p. 14.
1901. *Rhagovelia whitei,* Kirkaldy, Ent., vol. 34, p. 308 (places in genus *Rhagovelia*).
1931. *Rhagovelia whitei,* Gould, Kansas Univ. Sci. Bull., vol. 20, p. 47 (quotes original description).
1931. *Rhagovelia whitei,* Drake and Harris, Pan-Pacific Ent., vol. 8, p. 34 (record from Chapada, Brazil).

Size:	*Length*	*Width*
	4.00 mm. apterous male	1.33 mm. apterous male
	4.11 mm. apterous female	1.40 mm. apterous female

Color: General color brown, covered with golden pubescence. Pronotum brown-black with orange-brown band on anterior fifth. Connexiva broadly margined with orange-brown. Venter with mesosternum orange-yellow, metasternum and first three or four abdominal segments brown, remaining segments progressively lighter brown, first genital segment yellow except at apex, second genital segment brown. Base of antennae, all coxae and trochanters, bases of anterior and posterior femora yellow when viewed from above. All femora yellow in ventral view.

Structural characteristics: Pronotum of apterous forms covers mesonotum. Dorsum of abdomen of apterous female tapers evenly to apex. Posterior tibia without sickle-shaped spur at apex. *Apterous male:* anterior trochanter unarmed, anterior tibia only slightly dilate and slightly excavate on anterior fifth. Pronotum wider than long (L. 65, W. 83) and covering mesonotum. Metanotum (L. 5, W. 83) nearly hidden by apex of pronotum in middle. Proportions of antennae: Seg. I: II: III: IV:: 68: 35: —: —; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 135: 98: 35: 57; of posterior legs: 120: 107: 7: 25. Abdomen tapers evenly to apex. Ventral carina present, becoming evanescent on last two abdominal segments. Minute, black, conical setae on jugum of head, proepisternum, mesosternum and venter of abdomen with exception of last segment on which minute conical or tooth-shaped setae are concentrated into one row along each side of posterior edge of segment. Posterior trochanter armed with from no to three very small knoblike teeth and one long, straight spine. Posterior femur greatly incrassate (L. 120, W. 50) and flattened beneath. Armed on basal half with median row of very small knoblike teeth; apical half armed with two lateral rows of spines, the anterior row starts just before middle and consists of about five knoblike teeth, then a short spine followed by a stout, curved spine beneath apex, the posterior row starts at approximately middle with one small spine followed by three very small, knoblike teeth then two increasing spines to apex. Posterior tibia curved inward to apical one fourth and curved slightly outward from there to apex; noticeably laterally flattened; denticulate within with last three or four teeth increasingly enlarged; armed with spur at apex. *Apterous female:* pronotum formed as in male (L. 68, W. 87). Proportions of antennae: 68: 37: 37: 32; of intermediate legs: 125: 92: 34: 56; of posterior legs: 110: 97: 9: 25. Abdomen tapers evenly to apex. Minute, conical, black setae arranged as in male except not apparent on last abdominal segment. Posterior trochanter unarmed. Posterior femur not as incrassate as in male (L. 110, W. 32); armed on basal half with one median knoblike tooth followed by one moderate spine just before middle, apical half of femur armed with two rows of spines, the anterior row starts at apical one fourth and consists of about three small spines decreasing in size to apex, the posterior row of spines starts after middle with one long bent spine followed by approximately four, smaller, decreasing spines to apex. Posterior tibia almost straight and denticulate within, teeth more closely set on basal two thirds; armed at apex with straight spur. *Winged forms:* unknown.

Comparative notes: This species resembles R. *scitula* sp. nov. The posterior tibia of the male of *R. whitei* (Breddin) is definitely laterally flattened on the basal two thirds and curved outward for the apical one third while that of *R. scitula* sp. nov. is cylindrical and arcuate. The posterior femur of the female of *R. whitei* (Breddin) is armed with a moderate spine before the long spine at the middle while the moderate spine is missing in those females of *R. scitula* sp. nov. at hand. The color of the spots on the dorsum of the abdomen is constant on all the specimens available for study, being dark, shining brown in *R. whitei* (Breddin) and yellow to yellow-brown in *R. scitula* sp. nov.

Data on types: Breddin's types are supposed to be in the Berlin Museum, but Dr. Hungerford, in his notes on his 1928 European trip, does not mention them as being there. The type locality is given as "Lagoa Santa" Brazil.

Data on distribution:

BRAZIL: Chapada, June (U. S. N. M.), 1 apterous male; Chapada, Aug. (Iowa State College Collection) 1 apterous male, 1 apterous female.

Rhagovelia williamsi Gould

(Pl. V, fig. 17)

1931. *Rhagovelia williamsi* Gould, Kansas Univ. Sci. Bull., vol. 20, p. 47.
1935. *Rhagovelia williamsi*, Drake and Harris, Proc. Biol. Soc. Washington, vol. 48, p. 33 (incorrectly place *R. williamsi* Gould as a synonym of *R. amazonensis* Gould).

Size:	*Length*	*Width*
	3.56 mm. apterous male	1.17 mm. apterous male
	3.69 mm. apterous female	1.35 mm. apterous female

Color: General color brown-black, clothed with golden pubescence. Anterior one fifth of pronotum yellow, becoming pruinose at sides. Dorsum of abdomen with first and fourth segments pruinose. Margins of connexiva orange to brown. Venter brown-black to gray-black. Venter of last abdominal segment brown beneath. Base of antennae, margins of all acetabulae, all coxae, anterior and posterior trochanters, and bases of anterior and posterior femora yellow to orange.

Structural characteristics: Pronotum of apterous forms covers mesonotum. Dorsum of abdomen tapers evenly to apex in apterous female. Posterior tibia without sickle-shaped spur at apex. *Apterous male:* anterior trochanter unarmed. Anterior tibia only slightly flattened within and not dilate. Pronotum broadly rounded behind (L. 52, W. 71). Metanotum short on midline (L. 7, W. 72).

Proportions of antennae: Seg. I: II: III: IV:: 54: 31: 32: 32; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 116: 87: 35: 50; of posterior legs: 98: 78: 4: 19. Abdomen tapers rather evenly to apex with slight increase in angle of taper on last three segments. Connexiva semivertical. Venter without median carina. No black, minute conical setae on base of jugum of head, proepisternum or on posterior edge of venter of last abdominal segment at sides. Posterior trochanter armed with three or four short teeth and one longer tooth. Posterior femur moderately incrassate (L. 98, W. 30); armed on basal one half with one row of knoblike teeth ending in one moderate spine before middle; armed at middle with one long spine followed by seven or eight rapidly decreasing spines to apex, and an anterior row of five or six decreasing spines to apical one third. Posterior tibia armed within with two rows of subequal teeth with those of basal one third slightly stouter; armed at apex with stout spur. *Apterous female:* anterior leg formed as in male. Pronotum broadly rounded behind (L. 60, W. 80). Metanotum short on midline (L. 6, W. 82). Proportions of antennae: 60: 34: 34: 33; of intermediate legs: 123: 91: 34: 54; of posterior legs: 100: 80: 5: 22. Dorsum of abdomen tapering rather evenly to apex. Connexiva vertical. Minute, conical setae absent as in male. Posterior trochanter unarmed. Posterior femur moderately incrassate (L. 100, W. 25); armed on basal one half with one moderate spine which may be reduced or absent; armed at middle with one long spine followed by six or seven rapidly decreasing spines to apex; usually armed with an anterior row of inconspicuous spines on apical one third. Posterior tibia slightly arcuate; armed within with two rows of subequal teeth with those of basal one third somewhat stouter; armed at apex with stout spur. *Winged forms:* unknown.

Comparative notes: This species resembles *R. amazonensis* Gould. *R. williamsi* Gould can be separated from *R. amazonensis* Gould by the armature of the posterior femur of the male which has a moderate sized spine preceding the long spine at the middle, and by the longer than wide (L. 29, W. 23) dorsum of the first genital segment of the female. The dorsum of the second abdominal segment of the female does not have the longer hairs and golden pubescence such as is on the dorsum of the first and third abdominal segments in *R. williamsi* Gould, while in *R. amazonensis* Gould the second segment is clothed the same as the first and third. This species was said by Drake and Harris to be inseparable from *R. amazonensis* Gould but, in view of the characters which can be used to separate the two species, it is the opinion of the author that *R. williamsi* Gould is closely related to, but distinct from *R. amazonensis* Gould and should be regarded as a valid species.

Data on types: Holotype, apterous male; allotype, apterous female; paratypes, 9 apterous males, 11 apterous females. The type series was collected in Tena, Ecuador, Feb. 28, 1923, by F. X. Williams. The above type series is in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on distribution: In addition to the type specimens, specimens from the following locality have been examined:

ECUADOR: Oriente, Jatun Yacu, 700 m.a.s.l., E. Río Napo Watershed, Mar., 1937, Clarke-MacIntyre, 8 apterous males, 4 apterous females.

HIRTIPES GROUP

Group characteristics: The *hirtipes* group can be characterized as consisting of those species of the genus *Rhagovelia* in which the dorsum of the abdomen of the apterous female is carinate on the midline after the first two segments, and tapers more or less evenly to the apex. The intermediate femur of the female is cylindrical throughout. The last two tarsal segments of the intermediate leg of the apterous female are equal in length. (The distinctive proportionate measurements and the peculiar shape of the male clasper have made it desirable that this single species be placed in a group by itself pending the discovery of related forms. Obviously, group characteristics and specific characteristics can be easily confused in this case. Further clarification of these matters must await additional species in this group.)

Rhagovelia hirtipes Drake and Harris

(Pl. VII, fig. 9)

1927. *Rhagovelia hirtipes* Drake and Harris, Proc. Biol. Soc. Washington, vol. 40, p. 136 (describe from winged female from Honduras).
1931. *Rhagovelia hirtipes,* Drake and Harris, Pan Pacific Ent., vol. 8, p. 35 (add descriptions of winged male and apterous forms; record from Guatemala).
1931. *Rhagovelia hirtipes,* Gould, Kansas Univ. Sci. Bull., vol. 20, p. 34.

Size:	*Length*	*Width*
	4.40 mm. apterous male	1.33 mm. apterous male
	4.45 mm. apterous female	1.50 mm. apterous female
	4.33 mm. winged male*	1.60 mm. winged male
	4.28 mm. winged female*	1.66 mm. winged female

Color: General color pruinose black, clothed with golden pubescence. Pronotum with anterior band yellow behind vertex of head,

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* Wings broken away at apex. The measurement given is to apex of genital segments.

becoming pruinose black behind eyes. Margins of connexiva brown. Dorsum of last abdominal segment with brown to yellow shining median spot. Venter blue-gray. Venter of last abdominal segment brown beneath. Base of antennae, margins of all acetabulae, all coxae and trochanters, and bases of anterior and posterior femora beneath yellow.

Structural characteristics: Pronotum of apterous forms covers mesonotum. Dorsum of abdomen of apterous female tapers rather evenly to apex. Posterior tibia without sickle-shaped spur at apex. *Apterous male:* anterior trochanter unarmed. Anterior tibia flattened within; not dilate. Pronotum with width subequal to length (L. 80, W. 81). Metanotum short on midline (L. 6, W. 81). Proportions of antennae: Seg. I: II: III: IV:: 69: 40: 44: 43; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 148: 115: 59: 56; of posterior legs: 125: 135: 20: 25. Abdomen tapers evenly to apex at first; angle of taper increasing on last three segments. Connexiva semivertical. Venter of abdomen without median carina. Minute, conical setae absent on base of jugum of head, on proepisternum, and on posterior margin of venter of last abdominal segment at sides. Posterior one half of venter of last abdominal segment beneath depressed on each side of median line. First genital segment strongly curved downward on posterior one half. Posterior trochanter armed with from four to twelve small, knoblike teeth. Posterior femur strongly incrassate (L. 125, W. 43); armed on basal one third with a row of knoblike spines, armed at basal one third with one long spine followed by eight to twelve much smaller, gradually decreasing spines to apex; also armed with anterior row of small, subequal spines from before middle to apex. Posterior trochanter straight; armed within with irregular row of stout, subequal teeth; armed at apex with short spur. *Apterous female:* anterior leg as in male. Pronotum broadly rounded behind (L. 82, W. 90). Metanotum short on midline (L. 11, W. 96). Proportions of antennae: 70: 40: 43: 42; of intermediate legs: 140: 115: 59: 59; of posterior legs: 110: 132: 20: 27. Dorsum of abdomen tapering more or less evenly to apex. Margins of connexiva semivertical to flat at first, abruptly becoming vertical over dorsum of third abdominal segment, usually becoming semivertical again for last two segments. Dorsum of abdomen usually noticeably carinate on midline of third, fourth, and fifth segments with segments somewhat depressed at the sides. Posterior trochanter unarmed. Posterior femur only slightly incrassate (L. 110, W. 20); armed at apical one third with one moderate spine followed by four or five smaller, decreasing spines to apex. Posterior tibia straight and apparently unarmed. *Winged forms:* proportions and armature similar to apterous forms. Pronotum (L. 111, W. 102) clothed with brown hairs at apex; not produced into spiniform process in either sex.

Comparative notes: This species resembles *R. nitida* Bacon. *R. hirtipes* Drake and Harris can be separated from *R. nitida* Bacon by the lack of a ventral carina and by the armed posterior trochanter in the male; the females can be separated by the nature of the connexiva and by the dorsal, median carina on the abdomen of *R. hirtipes* Drake and Harris. The intermediate tarsal segments are longer than the tibia, and the second tarsal segment of the posterior leg is over three fourths as long as the third tarsal segment in *R. hirtipes* Drake and Harris.

Data on types: Holotype, winged female, collected in San Pablo, Honduras. Allotype, winged male, morphotypes, apterous male and female, all collected in Chiquimula, Guatemala. The type material is in the personal collection of Dr. C. J. Drake.

Data on distribution: Recorded from Honduras and Guatemala. Specimens have been examined from the following localities (new distribution for major political areas are indicated with an asterisk):

GUATEMALA: Chiquimula, June, 1930, (metatypes), 1 apterous male, 2 apterous females.

* MEXICO: * *Distrito Federal:* Xochimilco, June 21, 1934, H. E. Hinton, 2 apterous males, 2 apterous females.

* *Guerrero:* Malimaltepec, 4-30-30, Prof. L. Schultze, 3 apterous males, 3 apterous females; Puente de Ixtla, 7-12-37, H. D. Thomas, 1 winged male, 1 winged female.

* *Morelos:* Cuernavaca, 7-8-36, H. D. Thomas, 9 apterous females; Cuernavaca, 10-5-36, H. D. Thomas, 4 apterous males, 12 apterous females; 7-14-36, H. D. Thomas, 1 apterous male.

COLLARIS GROUP

Group characteristics: The *collaris* group can be characterized as consisting of those species of the genus *Rhagovelia* in which the dorsum of the abdomen of the apterous female is narrow after the first three segments, the intermediate femur of the female is flattened beneath at the base. The anterior tibia of the male is usually greatly dilate and excavate within. Winged forms are common: the wings just cover the apex of the genital segments.

The following species comprise this group:

1. *R. acuminata* sp. nov.
2. *R. armata* (Burmeister)
3. *R. collaris* (Burmeister)
4. *R. cuspidis* Drake and Harris
5. *R. impensa* sp. nov.
6. *R. planipes* Gould
7. *R. scabra* sp. nov.
8. *R. solida* sp. nov.
9. *R. tayloriella* Kirkaldy

KEY TO SPECIES OF THE COLLARIS GROUP

1. Terminal genital segment prolonged into a spinelike process 2
Terminal genital segment not prolonged into a spinelike process 3
2.(1) Connexivum terminating in a spine only in female .... *acuminata*
Connexivum terminating in a spine in both male and female, *cuspidis*
3.(1) Minute, conical, black setae thickly scattered on base of jugum of head and on posterior edge of last abdominal segment at the sides 4
Without such setae 8
4.(3) Minute, conical, black setae thickly scattered on proepisternum, mesosternum and venter of abdomen 5
Without such setae on proepisternum or venter of abdomen, or very sparsely scattered 6
5.(4) Anterior tibia greatly dilate and excavate in male, venter of abdomen of female with minute, black, conical setae on all segments but the last .... *scabra*
Anterior tibia not greatly dilate and excavate in male, venter of female without conical setae on last 3 or 4 abdominal segments, *solida*
6.(4) Whole body practically the same red-brown color .... *planipes*
Dorsum of body brown-black, venter red-brown in part 7
7.(6) Venter of male depressed between the posterior trochanters and coxae; abdomen of female horizontal .... *armata*
Venter of male not depressed on basal segments; abdomen of female turned upward at an angle of 15°, genital segments bent downward 45° .... *impensa*
8.(3) Venter of last abdominal segment of male roundly excavate on posterior 2/3 with a median furrow on anterior 1/3; intermediate trochanter brown to black beneath on all forms ...... *tayloriella*
Venter of last abdominal segment of male flattened beneath but not as above; intermediate trochanter of all forms yellow beneath, *collaris*

Rhagovelia acuminata sp. nov.

(Pl. VI, fig. 5)

Size:	*Length*	*Width*
	5.60 mm. apterous male	1.42 mm. apterous male
	6.01 mm. apterous female	1.56 mm. apterous female
	5.78 mm. winged male	1.79 mm. winged male
	6.25 mm. winged female	1.93 mm. winged female

Color: General color red-brown, covered with golden pubescence. Anterior one sixth of pronotum with band of yellow-brown;

pronotum also with slightly lighter longitudinal median line becoming evanescent on posterior portion. Margins of connexiva yellow brown. Venter slightly lighter in color than dorsum. All legs slightly darker than venter. Wings brown, veins prominent and darker brown.

Structural characteristics: Dorsum of abdomen of apterous female narrowed after first three segments, connexiva vertical; anterior tibia moderately dilate and excavate in male. *Apterous male:* anterior trochanter unarmed; anterior tibia moderately dilate (W. 15) and slightly excavate for apical half. Pronotum with length subequal to width (L. 93, W. 91); metanotum much wider than long (L. 5, W. 94). Proportions of antennae: Seg. I: II: III: IV:: 85: 50: 45: 41; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 195: 135: 60: 67; of posterior legs: 167: 140: 14: 31. Abdomen tapers evenly to apex. Terminal genital segment mucronate. Ventral carina most strongly produced between posterior coxae where venter is depressed on each side, gradually becoming evanescent just before last segment of abdomen. Minute, black, conical setae scattered on base of jugum of head, metasternum, venter of abdomen, and along posterior margin of last abdominal segment at sides. Venter of last abdominal segment flattened for its entire length, bordered on each side with slight callus. Posterior trochanter armed with approximately three small teeth. Posterior femur moderately incrassate (L. 167, W. 35) and armed with small spines on basal two fifths, followed by one long spine just before middle and approximately nine decreasing spines to apex; also with an anterior row of approximately eight small spines beginning just beyond middle and continuing to apex. Posterior tibia straight; closely set with two rows of subequal teeth with last tooth slightly enlarged; posterior tibia also armed with stout, slightly bent spur on apical margin. *Apterous female:* anterior tibia flattened for apical half, scarcely dilate. Pronotum slightly wider than long (L. 95, W. 103); metanotum slightly longer than in male (L. 9, W. 95). Proportions of antennae: 85: 49: 44: 40; of intermediate legs: 190: 135: 55: 65; of posterior legs: 165: 145: 13: 30. Connexiva vertical; narrowed in at first, then widened slightly, narrowed at apex and reflexed so as to have points nearly touching; each connexivum ends in a mucronate process. Dorsum of abdomen narrow after first three segments. Dorsum of first abdominal segment swollen, shelflike and partially covering second from above, thickly beset with long, dark hairs. Terminal genital segment mucronate. No ventral carina, and abdomen not depressed between posterior coxae. Minute, black, conical setae as in male. Posterior trochanter unarmed. Posterior femur slightly incrassate (L. 165, W. 28); armed at middle with one long, dark-tipped, amber spine followed by approximately six much smaller, subequal, dark spines; also with an anterior row of approximately four very small, widely-spaced spines on apical one third. Posterior tibia straight; armed for its entire length with small teeth, those of the basal half slightly larger; armed at apex with stout spur. *Winged male:* proportions and armature same as for apterous male. Mucronate genital segment projects from under wings so as to be visible from above. Connexiva not mucronate at apex. Pronotum drawn out into short spine (L. 15). *Winged female:* proportions and armature same as for apterous female. Connexiva mucronate at apex, not reflexed, tips visible from above, projecting from under wings. Genital segment mucronate and projects from under the wings so as to be visible from above. Pronotum drawn out into long, slightly-bent process which tapers to point at its apex (L. 68).

Comparative notes: This species resembles *R. cuspidis* Drake and Harris. *R. acuminata* sp. nov. can be distinguished from *R. cuspidis* Drake and Harris by the lack of a terminal spine on the connexivum of the male, by the red-brown color, and by the larger size.

Data on types: Holotype, apterous male; allotype, apterous female; holomorphotype, winged male; allomorphotype, winged female; paratypes, 3 apterous males, 1 apterous female; paramorphotypes, 81 winged males, 90 winged females. Described from a series labeled: "Panama, Feb. 4, 1935, Col. by J. W. McSwain for Robert Wind." All type specimens are in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on distribution: In addition to the type material, specimens have been examined from the following localities:

PANAMA: Potrerillos, 2-19-34, D. V. Brown, 7 apterous males, 22 winged males, 1 apterous female, 17 winged females; Potrerillos, 2-15-35, D. V. Brown, 8 winged males, 1 winged female; Potrerillos, 2-18-35, D. V. Brown, 15 winged males, 16 winged females; Potrerillos, 2-20-35, D. V. Brown, 2 winged males, 2 winged females; Potrerillos, 2-22-35, D. V. Brown, 6 winged males, 7 winged females; Potrerillos, 2-25-35, D. V. Brown, 7 winged males, 5 winged females; Potrerillos, 3-9-35, D. V. Brown, 8 winged males, 3 winged females.

Rhagovelia armata (Burmeister)

(Pl. VI, fig. 6)

1835. *Velia armata* Burmeister, Handb. der Ent., Bd. 2, p. 212.
1865. *Rhagovelia armata,* Mayr, Verh. Zool.-bot. Ges. Wien, Bd. 15, p. 445 (places in the genus *Rhagovelia*).
1896. *Rhagovelia armata,* Lethierry and Severin, Cat. Gén. des Hémip. 3, p. 55.
1898. *Rhagovelia armata,* Champion, Biol. Centr. America, Het., vol. 2, p. 136 (redescribes from Burmeister's type).
1901. *Rhagovelia armata,* Kirkaldy, Ent., vol. 34, p. 308 (mentions in key).
1910. *Rhagovelia armata,* Banks, Cat. of Nearctic Hemip.-Heter., p. 27.
1916. *Rhagovelia armata,* Van Duzee, Check List of Hemip.
1917. *Rhagovelia armata,* Van Duzee, Cat. Hemip. America N. of Mexico, p. 435.
1919. *Rhagovelia armata,* Hungerford, Kansas Univ. Sci. Bull., vol. 11, p. 130 (quotes Champion's redescription, records from Texas).
1931. *Rhagovelia armata,* Gould, Kansas Univ. Sci. Bull. vol. 20, p. 17 (redescribes, gives distribution as Mexico and Texas).
1931. *Rhagovelia armata,* Drake and Harris, Pan Pacific Ent., vol. 8, p. 34 (record from Guatemala).
1935. *Rhagovelia armata,* Drake and Harris, Proc. Biol. Soc. Washington, vol. 48, p. 33 (record from West Indies, describe variations in armature, etc.).

Size:

Length	*Width*
4.80 mm. apterous male	1.33 mm. apterous male
5.15 mm. apterous female	1.46 mm. apterous female
5.40 mm. winged male	1.73 mm. winged male
5.45 mm. winged female	1.82 mm. winged female

Color: General color brown-black; clothed with golden pubescence. Anterior band of pronotum yellow behind vertex of head, becoming pruinose behind eyes. Dorsum of last abdominal segment shining black. Margins of connexiva yellow. Mesosternum more or less yellow as are venters of the last three or four abdominal segments; remainder of venter blue-gray to gray-black. Base of antennae, margins of all acetabulae, all coxae, trochanters, base of anterior femur, base of posterior femur above and all of posterior femur beneath yellow. Wings dark brown; veins black.

Structural characteristics: Dorsum of abdomen of apterous female narrow after first three segments, connexiva vertical; anterior tibia moderately dilate and excavate beneath in male. *Apterous male:* anterior trochanter unarmed; anterior tibia moderately dilate and excavate on apical one half. Pronotum rounded behind (L. 75, W. 85), and covering mesonotum. Metanotum short on midline (L. 7, W. 85). Proportions of antennae: Seg. I: II: III: IV:: 70: 40: 42: 40; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 103: 106: 47: 60; of posterior legs: 130: 111: 13: 27. Abdomen tapers evenly to apex. Venter of abdomen depressed for first three segments; ventral carina present on basal segments of abdomen, becoming evanescent on next to last segment. Minute, black, conical setae on base of jugum of head, sparsely on venter of abdomen, and along venter of last abdominal segment at sides. Venter of last abdominal segment shallowly excavate on posterior one half, anterior one half with two hairy prominences with shallow trough between. Posterior trochanter armed with several small teeth. Posterior femur greatly incrassate (L. 130, W. 44); armed on basal two fifths with one row of short, subequal spines; armed on apical three fifths with a larger posterior row which begins at basal two fifths with one long spine followed by eight or ten smaller, gradually decreasing spines, and a smaller, anterior row of subequal spines which begins at basal two fifths and continues to apex. Posterior tibia straight; armed within with small teeth with those at apical one third tending to be stouter; armed at apex with stout spur. *Apterous female:* anterior tibia shallowly excavate and not as dilate as in male. Pronotum rounded behind (L. 77, W. 101); metanotum as in male (L. 6, W. 100). Proportions of antennae: 71: 38: 40: 36; of intermediate legs: 146: 105: 50: 59; of posterior legs: 130: 120: 14: 30. Dorsum of abdomen narrow after first three segments. Connexiva vertical; narrowing after first three segments, then diverging slightly, narrowing again over the last segment and diverging at apex. Venter not depressed as in male; no ventral carina. Minute, black, conical setae as in male, except much more reduced at sides of last abdominal segment. Intermediate femur somewhat flattened beneath at base. Posterior trochanter unarmed. Posterior femur not as incrassate as in male (L. 130, W. 30); armed with one long spine after middle followed by approximately six, smaller, gradually decreasing spines to apex. Posterior tibia straight; armed within with dark teeth and spur at apex. *Winged forms:* proportions and armature similar to apterous forms. Wings barely covering apex of genital segments. *Winged male:* venter formed as in apterous male. Pronotum continued into short, pointed process (L. 13). *Winged female:* pronotum continued into long, curved, sharply pointed process (L. 50).

Comparative notes: This species has been misidentified frequently in the past. Much of this is due to Champion's figuring an apterous female (1901-pl. VIII) which belongs to the crassipes group as the female of *R. armata* (Burmeister). *R. armata* (Burmeister) is closely related to *R. planipes* Gould, but can be separated from that species by the formation of the venter of the male, which is depressed for the basal three segments, and excavate on the posterior one half of the apical segment. The females of *R. armata* may be separated from those of *R. planipes* by the darker colored venter of the abdomen which is orange in *R. planipes*. *R. armata* (Burmeister) is also closely related to *R. scabra* sp. nov. but can be separated from that species at once by the lack of the thickly scattered minute, conical, black setae on the venter of the thorax.

Data on types: Burmeister's types are in the Berlin Museum. The type specimens were collected in Mexico. The female figured by Champion was not from the type series but was from the Vienna Museum and had been identified by Mayr.

Data on distribution: Recorded from Mexico, Guatemala, West Indies, and Texas. How many of these records are based on misidentified specimens, it is impossible to state. Specimens from the following localities have been examined (new records for major political areas are indicated with an asterisk):

* COSTA RICA: Río Virilla, 12-26-31, Heinrich Schmidt, 2 apterous males, 2 winged males, 2 apterous females, 2 winged females; San Isidro del Gen., 2000 ft., Feb., 1939, Dean L. Rounds, 2 apterous males; San José, purchased 1932, Heinrich Schmidt, 1 apterous male, 1 winged male, 3 apterous females, 1 winged female.

GUATEMALA: Amatitlan, Feb. 8, 1905 (J. R. de la Torre-Bueno Collection) 14 apterous males, 20 apterous females; Mazatenango, Feb. 3, 1905 (J. R. de la Torre-Bueno Collection) 3 winged males, 1 winged female.

* HONDURAS: Copán, 2-18-1937, Chester Roys, 1 apterous male, 2 apterous females.

Rhagovelia collaris (Burmeister)

(Pl. VI, fig. 7)

1835. *Velia collaris* Burmeister, Handb. der Ent., Bd. 2, p. 212.
1857. *Velia fiebrii* Guérrin, *in* Sagra's Nat. Hist. Cuba, vol. 2, 7, p. 174.
1865. *Rhagovelia collaris,* Mayr, Verh. Zool-bot. Ges. Wien, Bd. 15, p. 445.
1867. *Rhagovelia collaris,* Mayr, Reise d Oster Freg. Nov., Zool. Bd. 2, p. 180.
1872. *Rhagovelia collaris,* Uhler, Proc. Boston Soc. Nat. Hist., vol. 19, 4, p. 434.
1892. *Rhagovelia collaris,* Johnston and Fox, Ent. News, vol. 3, p. 60 (record from Jamaica).
1896. *Rhagovelia collaris,* Lethierry and Severin, Cat. Gén. des Hémip., vol. 3, p. 55.
1898. *Rhagovelia collaris,* Champion, Biol. Centr. Amer., Het., vol. 2, p. 134.
1900. *Rhagovelia collaris,* Kirkaldy, Ento., vol. 33, p. 71.
1901. *Rhagovelia collaris,* Kirkaldy, Ento., vol. 34, p. 308.
1910. *Rhagovelia collaris,* Banks, Cat. of Nearctic Hemip.-Hetr., p. 27.
1931. *Rhagovelia collaris,* Gould, Kansas Univ. Sci. Bull., vol. 20, p. 21 (redescribes, gives distribution as San Domingo, Jamaica and Cuba).
1931. *Rhagovelia collaris pulchra* Gould, Kansas Univ. Sci. Bull., vol. 20, p. 22 (describes from B. W. I.).
1931. *Rhagovelia collaris,* Drake and Harris, Pan Pacific Ent., vol. 8, p. 34 (record variations and give distribution of Guatemala and Arizona).
1933. *Rhagovelia collaris pulchra,* Gould, Ann. Ent. Soc. America, vol. 26, p. 466 (records from Santo Domingo).
1933. *Rhagovelia collaris,* Gould, Ann. Ent. Soc. America, vol. 26, p. 466 (records from Cuba and Jamaica).

Size:

Length	*Width*
4.60 mm. apterous male	1.40 mm. apterous male
5.05 mm. apterous female	1.53 mm. apterous female
4.58 mm. winged male	1.78 mm. winged male
4.95 mm. winged female	1.80 mm. winged female

Color: General color brown-black, clothed with golden pubescence. Pronotum with anterior band yellow behind vertex of head, becoming pruinose behind eyes. Dorsum of abdomen pruinose toward sides. Margins of connexiva yellow. Venter orange beneath except metasternum and first two abdominal segments. Base of antennae, margins of all acetabulae, all coxae and trochanters, base of anterior femur, and base of posterior femur above, all of posterior femur beneath yellow.

Structural characteristics: Dorsum of abdomen of apterous female narrow after first three segments, connexivum vertical; anterior tibia greatly dilate and excavate in the male. *Apterous male:* anterior trochanter unarmed; anterior tibia greatly dilate (L. 87, W. 23) and excavate beneath after basal one third. Pronotum broadly rounded behind (L. 78, W. 88); mesonotum hidden; metanotum short on midline (L. 11, W. 85). Proportions of antennae: Seg. I: II: III: IV: : 74: 42: 44: 38; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III: : 150: 112: 47: 58; of posterior legs: 126: 124: 13: 27. Abdomen tapers evenly to apex. Venter with fairly distinct median carina on basal segments, becoming evanescent on next to last segment. Venter of last abdominal segment slightly excavate on posterior one half or can be flattened beneath. No minute, conical, black setae on base of jugum of head, on venter, or on last abdominal segment at sides. Posterior trochanter armed with several small teeth. Posterior femur greatly incrassate (L. 126, W. 38); armed on basal one third with one row of short, subequal spines; armed on apical three fifths with one larger posterior row which begins at basal two fifths with one long spine followed by ten or twelve gradually decreasing spines to apex, and a smaller, anterior row of subequal, small spines which begins at basal two fifths and continues to apex. Posterior tibia straight; armed within with small teeth with those on basal two thirds tending to be stouter; armed at apex with slender spur. *Apterous female:* anterior tibia slightly dilate and flattened within. Pronotum as in apterous male (L. 80, W. 92); metanotum as in male (L. 10, W. 93). Proportions of antennae: 75: 40: 44: 38; of intermediate legs: 148: 115: 48: 61; of posterior legs: 128: 132: 13: 27. Dorsum of abdomen narrow after first three segments. Connexiva semivertical to vertical; narrow after first three segments and continuing subparallel. Minute, conical, black setae absent. Intermediate femur slightly flattened beneath at base. Posterior trochanter unarmed. Posterior femur not as incrassate as in male (L. 128, W. 27); armed at apical two fifths with one long spine followed by four or five smaller, decreasing spines to apex. Posterior tibia straight; armed with inconspicuous teeth and a spur at apex. *Winged forms:* proportions and armature much as in apterous forms. Wings barely covering apex of genital segments. *Winged male:* venter formed as in apterous male. Pronotum produced into a short process at apex (L. 10). *Winged female:* pronotum produced into a long, bent, sharply-pointed process at apex (L. 45).

Comparative notes: This species resembles *R. tayloriella* Kirkaldy, but can be separated from that species by the intermediate trochanter of all forms being yellow beneath in *R. collaris* (Burmeister). Also the venter of the last abdominal segment of the male is differently formed in the two species. There is some variation in the incrassateness of the posterior femur in different specimens. This has been noted before by Drake and Harris (1931; p. 34). The specimens from Puerto Rica are somewhat foreshortened; however, all other characters are within logical range of variation so it was thought best not to describe these Puerto Rica specimens as a new subspecies. *R. collaris pulchra* Gould was found to be indistinguishable from *R. collaris* (Burmeister) and is made a synonym of it.

Data on types: Burmeister's type specimens are located in the Berlin Museum. The type series was collected in Port au Prince, Haiti.

Data on distribution: Recorded from Haiti, San Domingo, Jamaica, Cuba, Guatemala, and Arizona (?). Specimens from the following localities have been examined (new records for major political areas are indicated with an asterisk):

CUBA: Loc. Arroyo, Santa Clara Prov., June 22, 1932, P. J. Bermudez, 26 apterous males, 46 apterous females; Matanzas, Yumuri Valley, 9-19-33, P. J. Bermudez, 18 apterous males, 12 apterous females; Havana, F. Z. Cervera (J. R. de la Torre-Bueno Collection) 1 apterous male, 3 apterous females; Trinidad Mts., Mina Carlota, 22 March, 1925, 2 apterous males, 1 winged female; Matanzas, Yumuri Valley, 12-9-33, P. J. Bermudez, 2 apterous males, 4 apterous females; arroyo in Mena, West Matanzas, Yumuri Valley, 5-16-32, P. J. Bermudez, 6 apterous males, 1 winged male, 7 apterous females, 2 winged females.

DOMINICAN REPUBLIC: Roseau, 1-29-26, P. G. Howes (type series of *R. collaris pulchra* Gould) 4 apterous males, 1 winged male, 3 apterous females; Cristóbal, 7-10-30, R. M. Bond, 1 apterous male, 2 apterous females; Laudet, June 10, 1911 (U. S. National Museum Collection) 2 apterous males, 1 apterous female.

HAITI: Port au Prince, Mar. 1927, 5 apterous males, 3 apterous females; Mirebalais, 12-2-28, 15 apterous males, 6 apterous females.

* PUERTO RICA: Naranjito, July 6, 1915 (U. S. National Museum Collection), 1 winged male; Aibonito, July 14-17, 1914 (U. S. National Museum Collection), 1 apterous male; Adjuntas, June 8-13, 1915 (U. S. National Museum Collection), 1 apterous female; Barranguita, 2-20-27, W. A. Hoffman, 1 apterous male, 1 winged male, 2 apterous females; Anasco, 2-1-36, H. Lamoutte, 1 apterous male, 1 winged male, 1 apterous female; Luquillo Mts. (swim pool), No. 10-1, Feb. 18, 1935, Needham and Diaz, 3 apterous males, 1 winged male, 8 apterous females; Coquitas River, No. 329-11, March 4, 1935, Needham and Diaz, 1 winged male, 1 winged female; Río Blanco, No. 373-12, Mar. 6, 1935, Needham and Diaz, 2 apterous males, 2 apterous females; Micaco River, No. 428-14, March 7, 1935, Needham and Diaz, 1 winged female; Prieto River, No. 448-15, March 7, 1935, Needham and Diaz, 3 apterous males, 3 apterous females; Sabana River, No. 465-16, March 7, 1935, Needham and Diaz, 4 apterous males, 9 apterous females; Quebrada, La Joba, No. 414-2, March 8, 1935, Needham and Diaz, 11 apterous males, 2 winged males, 16 apterous females, 1 winged female; Carreras River, No. 504-14, March 9, 1935, Needham and Diaz, 1 apterous male, 1 winged male, 2 apterous females, 1 winged female; Arecibe Utuado, No. 545-22, March 13, 1935, Needham and Diaz, 1 apterous male, 1 winged male, 1 apterous female; Iuebrada, Tomey, No. 96-3, Feb. 21, 1935, Needham and Diaz, 2 apterous males; Lares, Guajataca River, No. 747-26, March 22, 1935, Needham and Diaz, 1 apterous male, 3 apterous females; Adjuntas Juyaya Rd., No. 868-30, March 24, 1935, Needham and Diaz, 3 apterous females, 1 winged female; Luquillo Mt. Rd. Km. 11.7, No. 1117-41, June 8, 1935, J. G. Diaz, 6 apterous males, 5 winged males, 6 apterous females, 1 winged female; El Yunque Trail, No. 1173-43, June 10, 1935, J. G. Diaz, 2 apterous males, 2 winged males, 2 apterous females; Luquillo Mts. (swim pool), No. 11-1, Nov. 18, 1935, Needham and Diaz, 1 apterous male, 10 apterous females; Luquillo Mts. (swim pool), No. 1773-39, Nov. 17, 1935, Needham and Diaz, 5 winged females; Luquillo Mts. (picnic grounds), No.

23-1, Nov. 12, 1935, Needham and Diaz, 3 apterous males, 1 winged male, 1 apterous female.

Rhagovelia cuspidis Drake and Harris

1933. *Rhagovelia cuspidis* Drake and Harris, Proc. Biol. Soc. Washington, vol. 46, p. 51.

This species is not represented in the material in the Francis Huntington Snow Entomological Collections, University of Kansas. The original description is quoted below:

"Black, thickly clothed with fine golden pubescence, the front margin of pronotum, connexival margins, base of first antennae, prosternum, all coxae, anterior and posterior trochanters, base of anterior femora and part of hind femora testaceous to brownish testaceous. Head with the usual impressed lines. Eyes large, coarsely faceted. Antennal formula, 45: 25: 27: ?, the second segment with long hairs on dorsal surface, the third slightly expanded. Pronotum extending over mesonotum, broadly rounded behind, with an indistinct median ridge, with rather numerous indistinct, but deep punctures. Abdomen tapering slightly posteriorly, the margins nearly straight, terminating behind in prominent somewhat laterally projecting spine like processes; last segment a little longer than preceding, with a patch above, shiny, the apex truncate. Last genital segment ending in a long sharp process. Legs moderately hairy, the anterior tibia strongly compressed, somewhat expanded and shallowly excavated beneath. Intermediate legs long; formula, 102: 76: 35: 38.

"*Apterous male.*—Venter bluish-black, clothed with longer hairs, last segment shiny black, strongly depressed behind, the apex truncate. Genital segments plump, the first segment carinate along median line at base. Clasper long, very broad at base, the terminal portion sub-cylindrical, of about equal width throughout, slightly curved inwardly, blunt at apex and about three times as long as basal portion. Hind femora rather strongly incrassate, reaching to genital segments, armed with nine or ten progressively shortened, black-tipped testaceous spines; the first of these is much longer than the others and situated slightly before the middle; also armed along the basal half, before the long spine, with a distinct row of closely set, black teeth and along the distal half, beneath the spines with an irregular row of short black teeth. Posterior trochanter with numerous short black teeth. Hind tibia nearly straight, armed within with numerous short black teeth, the apex with a long, stout, slightly-bent black spur.

"*Apterous female.*—Posterior femora slightly incrassate, with a row of black-tipped, testaceous spines in male. Connexivum broader than in male, the outer margins nearly straight, the apical spine as in male.

"Length, 4.42 mm.; width, 1.15 mm.

"*Holotype,* apterous male, and *allotype,* apterous female, Punta Gorda, Br. Honduras; authors' collection. *Paratypes,* three apterous males, taken with types.

"The connexival spines, the mucronate terminal abdominal segment, and the character of the armature of the hind femora will serve to separate this species from allied forms."

Comparative notes: This species may resemble *R. acuminata* sp. nov. The type material is all in the personal collection of Dr. C. J. Drake and has been unavailable for study. *R. cuspidis* Drake and Harris may be separated from *R. acuminata* sp. nov. by the spinelike termination of the connexivum of the male, by its black color, and by its smaller size.

Rhagovelia impensa sp. nov.

(Pl. VI, fig. 8)

Size:	*Length*	*Width*
	4.36 mm. apterous male	1.20 mm. apterous male
	4.77 mm. apterous female	1.40 mm. apterous female
	4.90 mm. winged male	1.62 mm. winged male
	5.30 mm. winged female	1.92 mm. winged female

Color: General color brown-black, clothed with golden pubescence. Pronotal band yellow behind vertex of head, becoming pruinose behind eyes. Dorsum of abdomen pruinose at sides. Margins of connexiva yellow. Venter yellow-brown to red-brown; darkest between intermediate coxae becoming almost brown-black on some specimens. Base of antennae, margins of all acetabulae, all coxae and trochanters, basal one half of anterior femur, and all posterior femur beneath yellow. Wings dark brown; veins black.

Structural characteristics: Dorsum of abdomen of apterous female narrow after first three segments, connexiva vertical to slightly reflexed, anterior tibia moderately dilate and excavate in male. *Apterous male:* anterior trochanter unarmed. Anterior tibia moderately dilate (L. 80, W. 20) and excavate on apical half. Pronotum rounded behind (L. 72, W. 80); metanotum short on midline (L. 9, W. 80). Proportions of antennae: Seg. I: II: III: IV:: 67: 39: 40: 36; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 136: 105: 44: 58; of posterior legs: 120: 110: 15: 29. Abdomen tapers evenly to apex. Connexiva semivertical. Ventral carina only evident on basal two segments becoming evanescent between posterior trochanters. Venter of last abdominal segment flattened to slightly excavate beneath. Minute, conical, black setae on base of jugum of head and along sides of venter of last abdominal segment. Posterior trochanter armed with four to five small teeth. Posterior femur moderately incrassate (L. 120, W. 35); armed on basal one third with row of short teeth and beyond basal one third with one long spine followed by approximately twelve smaller, gradually decreasing spines to apex; also armed on apical one half with an anterior row of small, subequal spines. Posterior tibia straight; armed within with closely set teeth on basal half, with those at approximately middle stouter; teeth of apical one half smaller and more widely spaced; armed at apex with stout spur. *Apterous female:* anterior tibia much as in male. Pronotum broadly rounded behind (L. 80, W. 95); metanotum as in male (L. 9, W. 95). Proportions of antennae: 70: 42: 44: 39; of intermediate legs: 142: 107: 47: 63; of posterior legs: 118: 120: 18: 30. Dorsum of abdomen narrow after first three segments. Connexiva vertical to semireflexed tentlike over dorsum of abdomen. Brown hairs thickly set on dorsum of last abdominal segment. Venter with no trace of median carina. Minute, black, conical setae as in male, except sparsely set on sides of venter of last abdominal segment. Intermediate femur flattened beneath for basal one third. Posterior trochanter unarmed. Posterior femur not as incrassate as in male (L. 120, W. 23); armed beyond middle with one long spine followed by four or five smaller, rapidly decreasing spines to apex; there may or may not be one or two small spines anterior to main row after apical one third. Posterior tibia straight; seemingly unarmed, or armed on basal one half with inconspicuous teeth; armed with spur at apex. *Winged forms:* proportions and armature similar to apterous forms. Wings just cover apex of genital segments. *Winged male:* pronotum prolonged at apex into a short, pointed process (L. 10). *Winged female:* pronotum prolonged at apex into long, narrow, cylindrical process (L. 50) which arises almost vertically from pronotum at first, then curves so that apex is directed slightly downward.

Comparative notes: This species resembles *R. armata* (Burmeister), but can be separated from that species by the normal basal segments of the venter of the abdomen in the male. The male clasper is also distinct, being more abruptly curved and with the blade widened near the apex, while the clasper of *R. armata* (Burmeister) is gradually curved and the blade tapers more evenly to the apex. The females of *R. impensa* sp. nov. can be separated from those of *R. armata* (Burmeister) by the abdomen being bent upward at an angle of fifteen degrees with the genital segments bent downward at an angle of forty-five degrees, while the abdomen and genital segments of the female of *R. armata* (Burmeister) are practically horizontal.

Data on types: Holotype, apterous male; allotype, apterous female; holomorphotype, winged male; allomorphotype, winged female; paratypes, 7 apterous males, 6 apterous females. The apterous specimens were collected in Lagunas Villa, Peru, on June 8 to July 1, 1934, by F. Woytkowski. The winged specimens were collected in the vicinity of Balsas, Peru River Marañon, 1179 m.a.s.l., June 26-29, 1936, by F. Woytkowski. All type specimens are in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on distribution: In addition to the type specimens, specimens from the following localities have been examined:

PERU: Dept. Cajamarco, 1179 m.a.s.l., River Marañon, Vic. of Balsas, June 26-29, 1936, F. Woytkowski, No. 3634, 4 apterous males, 1 apterous female; Santa Clara, River Rimac, 17 km. E. of Lima, Sept. 22-25, 1934, F. Woytkowski, 7 apterous males, 8 apterous females; Dept. Cajamarco, Andes, River Lallanga, Vic. Llangua, June 20, 1936, F. Woytkowski, No. 3633, 5 apterous males, 1 winged male, 6 apterous females; Dept. Cajamarco, Andes, 1600 m.a.s.l., Vic. Jerez, Rivulet Mineral, July 12, 1936, F. Woytkowski, No. 3635, 9 apterous males, 5 apterous females; Dept. Lima, Luria, 45 km. S. of Lima, pools near sea, Nov. 3-5, 1934, F. Woytkowski, 17 apterous males, 11 apterous females; Río Rimac, 17-44 km. E. of Lima, Nov. 27-29, 1934, F. Woytkowski, 17 apterous males, 20 apterous females; mouth of Río Rimac, close to Pacific, June, 1934, F. Woytkowski, 17 apterous males, 41 apterous females.

Rhagovelia planipes Gould

(Pl. VI, fig. 9)

1931. *Rhagovelia collaris planipes* Gould, Kansas Univ. Sci. Bull., vol. 20, p. 22.

Size:	*Length*	*Width*
	5.75 mm. apterous male	1.66 mm. apterous male
	6.15 mm. apterous female	2.06 mm. apterous female

Color: General color red-brown, clothed with golden pubescence. Pronotum with uninterrupted tan band on anterior one fifth, becoming slightly pruinose behind eyes. Three apical segments of antennae, anterior tibia and tarsus, apical half of intermediate tibia and all of tarsus, apical third of posterior tibia and all of tarsus brown. Venter entirely red-brown.

Structural characteristics: Dorsum of abdomen of apterous female narrow after first three segments, connexiva vertical; anterior tibia moderately dilate and excavate beneath in male. *Apterous male:* anterior trochanter unarmed. Anterior tibia moderately dilate (L. 110, W. 20) and excavate on apical half. Pronotum slightly wider than long (L. 95, W. 106); metanotum emarginate at apex (L. 8, W. 110). Proportions of antennae: Seg. I: II: III: IV:: 90: 55: 47: 44; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 185: 135: 62: 72; of posterior legs: 183: 147: 20: 35. Abdomen tapers evenly to apex. Minute, conical, black setae on base of jugum and at sides of posterior edge of last abdominal segment. Metasternum slightly raised in middle so as to appear as continuation of ventral carina. Ventral carina strong, with venter depressed on each side, extending to next to last segment; on some specimens only well developed on basal three segments. Last segment flattened. Posterior trochanter armed with approximately five small, dark teeth. Posterior femur greatly incrassate (L. 183, W. 65); armed on basal third with row of small closely-set dark spines followed by two rows of spines to apex, the posterior row begins at basal one third and consists of one long spine followed by series of seven rapidly decreasing spines, then another spine at apical one fourth fully as large as first spine at apical third, followed by two decreasing spines to apex; the anterior row consists of approximately fifteen subequal, small, closely-set spines which occur only in region between the two larger spines of femur. Posterior tibia curved inward for basal one half, outwards for apical one half, inner surface swollen from just before apical one third; armed with two rows of small, knoblike teeth on basal two thirds, with larger stouter teeth on apical one third; armed at apex with stout spur. *Apterous female:* anterior tibia moderately dilate (L. 107, W. 18), inner surface excavate for apical third. Pronotum wider than long (L. 98, W. 115); metanotum short on midline (L. 12, W. 122). Proportions of antennae: 85: 50: 42: 41; of intermediate legs: 168: 118: 54: 70; of posterior legs: 150: 146: 18: 33. Connexiva vertical, converging at first, then continuing subparallel. Dorsum of last abdominal segment thickly set with long, dark hairs. Minute setae on jugum and posterior edge of last abdominal segment as in male. No indication of median ventral carina. Posterior trochanter unarmed. Posterior femur moderately incrassate (L. 150, W. 35) and armed at middle with one long spine, followed by approximately six smaller, decreasing spines to apex; also armed with an anterior row of approximately four widely-spaced, small, knoblike spines beginning just before apical third. Posterior tibia straight; armed with subequal teeth with those of basal half more closely-spaced; armed with stout spur at apex. *Winged forms:* unknown.

Comparative notes: This species resembles *R. armata* (Burmeister), but can be separated from that species by the almost unicolorous venter and the characteristic armature of the posterior femur of *R. planipes* Gould. This species was originally named as a subspecies of *R. collaris* (Burmeister) however, the relationship of *R. planipes* to *R. collaris* is comparatively distant. In order to remain consistent, the variety *planipes* is elevated to species level.

Data on types: Holotype, apterous male; allotype, apterous female. Both specimens collected at Mt. Cacaquatique, Dept. St. Miguel, Salvador, 12-14-25, by R. A. Stirton.

Data on distribution: Recorded only from Salvador. In addition to the type specimens, specimens have been examined from the following locality (new records for major political areas are indicated with an asterisk):

* MEXICO: * *Chiapas:* Sierra Madre, btw. Finca Vergel and F. Victoria, 900 m.a.s.l., brk.-dp. shade, June 3, 1935, A. Dampf, 1 apterous male, 1 apterous female.

Rhagovelia scabra n. sp.

(Pl. VI, fig. 10)

Size:	*Length*	*Width*
	5.20 mm. apterous male	1.53 mm. apterous male
	5.65 mm. apterous female	1.73 mm. apterous female
	6.38 mm. winged male	2.02 mm. winged male

Color: General color red-brown, clothed with golden pubescence. Apical segments of antennae and legs brown. Anterior band of pronotum tan, not interrupted at middle. Disc of pronotum with more or less distinct median, longitudinal, tan line. Venter tan. Base of antennae, base of anterior and posterior femora, all coxae, and trochanters tan. Winged forms darker brown than apterous forms with veins of wings black.

Structural characteristics: Dorsum of abdomen of apterous female narrow after first three segments, connexiva vertical to slightly reflexed; anterior tibia of male greatly dilate and excavate. *Apterous* *male:* anterior trochanter unarmed; anterior tibia greatly dilate (L. 100, W. 25) and excavate on apical half. Pronotum wider than long (L.91,W.100); mesonotum hidden by pronotum; metanotum slightly emarginate on median line (L. 3, W. 100). Proportions of antennae: Seg. I: II: III: IV:: 70: 44: 47: 41; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 163: 122: 56: 63; of posterior legs: 135: 128: 18: 30. Abdomen tapers evenly to apex, connexiva semivertical. Venter, between posterior coxae, depressed on each side of median carina which becomes evanescent on next to last abdominal segment, last abdominal segment depressed on apical half. Minute black conical setae thickly scattered on jugum of head, venter of thorax and abdomen with exception of last abdominal segment on which minute, conical setae are slightly bent inward and arranged in one row along each side on posterior edge of segment. Posterior trochanter armed with several small, knoblike teeth. Posterior femur moderately incrassate (L. 135, W. 35) and armed along basal half with row of small, black, knoblike teeth; armed at middle with one large, curved spine followed by approximately seven smaller, decreasing spines to apex, also with an anterior row of subequal, small spines from middle to apex. Posterior tibia straight and armed within with small black teeth, also armed at apex with broad spur. *Apterous female:* anterior tibia only slightly dilate (L. 104, W. 20), slightly excavate on inner surface of apical one fourth. Pronotal proportions same as in male. Proportions of antennae: 73: 45: 47: 41; of intermediate legs: 160: 124: 57: 67; of posterior legs: 135: 143: 17: 30. Connexiva converging abruptly over dorsum of third abdominal segment then continuing subparallel to last segment where they diverge slightly. Dorsum of last abdominal segment between diverging connexiva thickly set with dark hairs. Venter with same minute, black, conical setae as in male, with those of last segment being concentrated in two or three rows along each side on posterior edge of segment. Intermediate femur flattened beneath on basal one third. Posterior trochanter unarmed; posterior femur only slightly incrassate (L. 135, W. 27) and armed at apical two fifths with one long, bent spine followed by five rapidly decreasing spines ending before apex; also armed with two short spines anterior to first and fourth spines of main row of spines. Posterior tibia straight and armed on basal half with small scattered teeth, apparently unarmed at apex. *Winged male:* anterior tibiae as in apterous male. Pronotum (L. 162, W. 133) prolonged into short spiniform process at apex (L. 10). Proportions of antennae and legs as in apterous male. Wings extend beyond apex of genital segments. Venter without carina well defined for first two segments, which are depressed, but otherwise as in apterous male. Minute, conical setae on venter as in apterous male. Form and armature of posterior legs same as in apterous male.

Comparative notes: This species resembles *R. armata* (Burmeister) and *R. planipes* Gould, but can be separated from either of those species by the extent of the minute, black, conical setae which extend down on the proepisternum, mesosternum and venter of abdomen in *R. scabra* sp. nov. *R. scabra* sp. nov. also resembles *R. solida* sp. nov. *R. scabra* sp. nov. can be separated from *R. solida* sp. nov. by the greatly dilate and excavate anterior tibia in the male, and by the presence of the conical setae beneath the venter on all but the last segment of the female.

Data on types: Holotype, apterous male; allotype, apterous female; holomorphotype, winged male. Paratypes, 8 apterous males, 6 apterous females; paramorphotypes, 4 winged males. Described from following specimens: Apterous forms collected in Costa Rica at an altitude of 2000 mtrs. Río Sarapiquí, by Heinrich Schmidt. Winged males, collected in Panama, C. A. Potrerillos, 2-18-1935, by D. V. Brown. All type specimens are in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on distribution: In addition to the type specimens, specimens from the following localities have been examined:

COSTA RICA: San José, 6 & 7, 1931, Heinrich Schmidt, 4 apterous males, 2 apterous females.

PANAMA: Potrerillos, 2-22-1935, D. V. Brown, 1 winged male; Coll. by J. W. McSwain for Robert Wind, Feb. 4, 1935, 2 winged males.

Rhagovelia solida sp. nov.

(Pl. VI, fig. 11)

Size:	*Length*	*Width*
	5.11 mm. apterous male	1.53 mm. apterous male
	5.48 mm. apterous female	1.96 mm. apterous female

Color: General color red-brown. Anterior portion of pronotum slightly lighter in color than remainder of pronotum but not set off as distinct band. Venter yellow-brown with last three segments of antennae, tibiae and tarsi of all legs darker brown.

Structural characteristics: Dorsum of abdomen of apterous female narrow after first three segments, connexiva vertical; anterior tibia moderately dilate and excavate in male. *Apterous male:* anterior trochanter unarmed; anterior tibia only moderately dilate

(L. 100, W. 20) and very slightly excavate on apical third. Pronotum broader than long (L. 84, W. 100) and evenly rounded behind. Mesonotum hidden by pronotum. Metanotum much wider than long (L. 7, W. 95). Proportions of antennae: Seg. I: II: III: IV:: 80: 45: 49: 43; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 160: 120: 55: 65; of posterior legs: 140: 125: 17: 32. Abdomen tapers evenly to apex. Connexiva semivertical. Venter with pronounced median carina between posterior coxae becoming evanescent between posterior trochanters. Posterior trochanter seemingly unarmed. Posterior femur greatly incrassate (L. 140, W. 47) and armed on basal one third with row of uniform, closely set, small teeth, followed just after basal one third with one large curved spine then approximately seven smaller spines to apex. Also armed with uniform row of small spines anterior to main row of spines. Posterior tibiae straight; armed with one row of subequal teeth, with those on basal half being larger and much more closely-set than those of apical half; armed at apex with slightly curved spur. *Apterous female:* pronotum formed much as in male (L. 90, W. 108), metanotum also as in male (L. 7, W. 100). Proportions of antennae: 84: 43: 46: 40; of intermediate legs: 153: 115: 53: 68; of posterior legs: 130: 132: 16: 33. Dorsum of abdomen narrow after first three segments. Connexiva vertical converging abruptly after first three abdominal segments, then continuing almost parallel. Thick patch of long brown hairs at apex of abdomen. Venter without median carina. Intermediate femur flattened beneath on basal one third. Posterior trochanter unarmed. Posterior femur not as incrassate as in male (L. 130, W. 32) and armed at middle with one long spine followed by seven rapidly decreasing spines to apex. Posterior tibia straight, armed on basal half with close set black teeth, seemingly unarmed on apical half except for spur at apex. *Winged forms:* unknown.

Comparative notes: This species resembles *R. scabra* sp. nov. but can be separated by the absence of the greatly dilate and excavate anterior tibia and the unarmed posterior trochanters in the male. The absence of the minute, black, conical setae beneath the venter of the female on the second and third from the last abdominal segments of *R. solida* sp. nov. separates the females. *R. solida* sp. nov. resembles *R. armata* (Burmeister) and *R. planipes* Gould, but can be separated from either of those species by the extent of the minute, black, conical setae which extend down on the proepisternum, mesosternum, metasternum and at least the basal two abdominal segments in *R. solida* sp. nov.

Data on types: Holotype, apterous male; allotype, apterous female; paratypes, 10 apterous males, 10 apterous females. Described from specimens labeled: "Costa Rica, Alt. 2000 mtr., Río Sarapiquí, Heinrich Schmidt." All type specimens are in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on distribution: Known only from type series.

Rhagovelia tayloriella Kirkaldy

(Pl. VI, fig. 12)

1900. *Rhagovelia tayloriella* Kirkaldy, Ent., vol. 33, p. 72.
1901. *Rhagovelia tayloriella,* Kirkaldy, Ent., vol. 34, p. 308 (mentions in key).
1931. *Rhagovelia tayloriella,* Gould, Kansas Univ. Sci. Bull., vol. 20, p. 44 (redescribes; gives distribution as Jamaica).

Size:	*Length*	*Width*
	4.35 mm. apterous male	1.33 mm. apterous male
	4.50 mm. apterous female	1.50 mm. apterous female
	4.55 mm. winged male	1.70 mm. winged male
	4.85 mm. winged female	1.80 mm. winged female

Color: General color brown-black, clothed with golden pubescence. Anterior band of pronotum yellow behind vertex of head, becoming pruinose behind eyes. Dorsum of last five abdominal segments of female blue-gray to gray-black, not clothed with golden pubescence or longer hairs. Dorsum of abdomen of male pruinose at sides, thickly clothed with golden pubescence and scattered long, brown hairs. Margins of connexiva yellow. Venter blue-gray with last two (male) to five (female) segments yellow beneath. Base of antennae, margins of all acetabulae, all coxae, anterior and posterior trochanters, and base of anterior femora yellow. Wings brown; veins black.

Structural characteristics: Dorsum of abdomen of apterous female narrow after first three segments, connexiva vertical; anterior tibia greatly dilate and excavate in male. *Apterous male:* anterior trochanter unarmed. Anterior tibia greatly dilate (L. 85, W. 22) and excavate on apical one half. Pronotum rounded behind (L. 81, W. 85); metanotum short on midline (L. 6, W. 87). Proportions of antennae: Seg. I: II: III: IV:: 70: 40: 45: 36; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 143: 110: 50: 60; of posterior legs: 118: 120: 13: 28. Abdomen tapers evenly to apex. Connexiva semivertical. Venter with median carina becoming evanescent on third or fourth from last segment. No minute, conical, black setae on base of jugum of head or along sides of venter of last abdominal segment. Venter of last abdominal segment beneath roundly and deeply excavate on posterior two thirds with median furrow on anterior one third. Posterior trochanter armed with four or five small teeth. Posterior femur moderately incrassate (L. 118, W. 30). Armed on basal one third with inconspicuous row of small teeth; armed just beyond basal one third with long spine followed by approximately ten smaller, gradually decreasing spines to apex; also armed on apical one half with an anterior row of small, inconspicuous, subequal spines. Posterior tibia straight; armed within with subequal teeth, and spur at apex. *Apterous female:* anterior tibia only slightly dilate (L. 87, W. 15) and flattened within. Pronotum rounded behind (L. 75, W. 92); metanotum as in male (L. 7, W. 95). Proportions of antennae: 74: 40: 42: 36; of intermediate legs: 145: 108: 45: 62; of posterior legs: 118: 122: 14: 26. Dorsum of abdomen narrow after first three segments. Margins of connexiva vertical and subparallel after first three segments. Dorsum of last five abdominal segments without golden pubescence and long brown hairs except at apex of last segment where there is a clump of long brown hairs. Venter without median carina. Minute, black, conical setae absent as in male. Intermediate femur flattened within on basal one fourth. Posterior trochanter unarmed. Posterior femur not as incrassate as in male (L. 118, W. 23); armed beyond middle with one slender spine followed by four or five much smaller, rapidly decreasing spines to apex. Posterior tibia straight and apparently unarmed except for slender spur at apex. *Winged forms:* proportions and armature similar to apterous forms. Wings just covering apex of genital segments. *Winged male:* venter formed as in apterous male. Pronotum continued into short (L. 14) process at apex. *Winged female:* pronotum continued at apex into long, curved process which arises at angle of forty-five degrees and curves around near apex and is directed slightly downward (L. 40).

Comparative notes: This species resembles *R. collaris* (Burmeister). *R. tayloriella* Kirkaldy can be separated from *R. collaris* (Burmeister) by the formation of the venter of the last abdominal segment in the male, and by the dorsum of the abdomen of the female being without short or long hairs for the last five segments. The armature of the posterior femur is also somewhat reduced in all forms of *R. tayloriella* Kirkaldy. Kirkaldy gives as one of his characters the incrassate condition of the third antennal segment of the male. This is an extremely variable condition and occurs to some extent in all the species of the *collaris* group.

Data on types: Kirkaldy states that the type is the winged male. In the J. R. de la Torre-Bueno Collection (now at the University of

Kansas) is a winged male bearing two hand-written labels: "Jam. Black R. Elysium Estate, Portland (2), C. B. T., 4-IV-99." and "*Rhagovelia tayloriella* Type Male." This winged male is the holotype of this species. With this specimen in the Bueno Collection were a winged female and 3 apterous males. These specimens bear labels in the same hand-writing as the type and are doubtlessly cotype material. These specimens are all in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on distribution: Recorded only from Jamaica. In addition to the type specimens, specimens have been examined from the following localities:

JAMAICA: Buff Bay R., 3-20-37, Chester Roys, 18 apterous males, 20 apterous females, 1 winged female; Claremont, Baron Hill, Trelawney, 3-4-28, L. G. Perkins, 4 apterous males, 1 winged male, 1 winged female; St. Ann, 8-1929, Lilly Perkins, 3 apterous males, 12 apterous females; Bath, St. Thomas, 3-29-37, Chester Roys, 8 apterous males, 11 apterous females; Spanish Town, April 10, 1937, Chester Roys, 52 apterous males, 4 winged males, 20 apterous females; Pt. Antonio, April, 1906, Van Duzee (J. R. de la Torre-Bueno Collection), 1 apterous male, 1 apterous female.

OBESA GROUP

Group characteristics: The *obesa* group can be characterized as consisting of those species of the genus *Rhagovelia* in which the dorsum of the abdomen of the apterous female is narrow after the first three segments, with the connexiva reflexed for the last four segments; all females have the intermediate femur dorsoventrally flattened; the terminal genital segments of both sexes are rounded or triangular but not mucronate. The winged forms vary in frequency of occurrence in the different species; the wings just cover the apex of the genital segments.

The following species comprise this group:

1. *R. distincta* Champion
2. *R. knighti* Drake and Harris
3. *R. obesa* Uhler
4. *R. oriander* Parshley
5. *R. rivale* Bueno

KEY TO SPECIES OF THE OBESA GROUP

1. Apterous female with apex of pronotum continued into a long, elevated process; apterous male with pronotum triangular with apex extending onto metanotum, mesonotum exposed at sides, *oriander*

Apterous female with pronotum not produced at apex; pronotum of apterous male not extending back over metanotum 2

2.(1) Connexiva of apterous female diverging over apex of last abdominal segment, apex of connexiva rounded as seen from the side; venter of last segment of male flattened beneath with prominent hairy ridges to each side . . . . *distincta*

Connexiva of apterous female close together or meeting at apex; apex of connexiva at least a 90° angle as seen from the side; male with last segment not as above 3

3.(2) Dorsum of abdomen of apterous male with only traces of median shining areas on a few segments; posterior trochanter of male unarmed. Mesonotum of apterous female tumid . . . . . . *rivale*

Dorsum of abdomen of apterous male and dorsum of metanotum with broad shining areas; posterior trochanter armed with several small teeth in male. Mesonotum of apterous female tumid only at sides if at all 4

4.(3) Margins of connexiva of apterous female with first two segments curved; exposed portion of mesonotum longer than exposed portion of metanotum . . . . *obesa*

Margins of connexiva of apterous female with first two segments straight; exposed portion of mesonotum shorter than exposed portion of metanotum . . . . *knighti*

Rhagovelia distincta Champion

(Pl. VII, fig. 4)

1877. *Rhagovelia mexicana* Signoret, Bull. Soc. Ent. Fr. (5); 7: p. 53 (no description).
1898. *Rhagovelia distincta* Champion, Biol. Centr. Amer. Het., vol. 2, p. 135.
1900. *Rhagovelia distincta,* Kirkaldy, Ento., vol. 33, p. 72.
1901. *Rhagovelia distincta,* Kirkaldy, Ento., vol. 34, p. 308.
1910. *Rhagovelia distincta,* Banks, Cat. Nearctic Hemip.-Heter., p. 27.
1916. *Rhagovelia distincta,* Van Duzee, Check List of Hemip.
1917. *Rhagovelia distincta,* Van Duzee, Cat. of Hemip. of America N. of Mexico, p. 435.
1919. *Rhagovelia distincta,* Hungerford, Kansas Univ. Sci. Bull., vol. 11, p. 129.
1921. *Rhagovelia distincta,* Torre-Bueno, Ent. News, vol. 32, p. 274.
1927. *Rhagovelia distincta,* Drake and Harris, Proc. Biol. Soc. Washington, vol. 40, p. 134 (report on variations in posterior legs).
1927. *Rhagovelia excellentis* Drake and Harris, Proc. Biol. Soc. Washington, vol. 40, p. 131 (describe from Colorado).
1931. *Rhagovelia distincta,* Gould, Kansas Univ. Sci. Bull., vol. 20, p. 25 (redescribes, gives distribution as South-western United States and Mexico; places *R. excellentis* Drake and Harris as a synonym).
1931. *Rhagovelia distincta arizonensis* Gould, Kansas Univ. Sci. Bull., vol. 20, p. 26 (describes from Arizona).
1931. *Rhagovelia distincta cadyi* Gould, Kansas Univ. Sci. Bull., vol. 20, p. 27 (describes from Wyoming).
1931. *Rhagovelia distincta harmonia* Gould, Kansas Univ. Sci. Bull., vol. 20, p. 28 (describes from Arizona).
1931. *Rhagovelia distincta modesta* Gould, Kansas Univ. Sci. Bull., vol. 20, p. 28 (describes from Mexico).
1931. *Rhagovelia distincta proxima* Gould, Kansas Univ. Sci. Bull., vol. 20, p. 29 (describes from Colorado).
1931. *Rhagovelia distincta valentina* Gould, Kansas Univ. Sci. Bull., vol. 20, p. 29 (describes from Texas and Arizona).
1933. *Rhagovelia distincta,* Gould, Ann. Ent. Soc. America, vol. 26, p. 466.

Size:

Length	*Width*
4.50 mm. apterous male	1.33 mm. apterous male
4.30 mm. apterous female	1.40 mm. apterous female
4.92 mm. winged male	1.66 mm. winged male
5.20 mm. winged female	1.72 mm. winged female

Color: General color black, clothed with fine, brown pubescence. Anterior band of pronotum interrupted at middle; orange behind vertex of head becoming pruinose behind eyes. Median, black, shining areas on all segments of dorsum of abdomen of male, and on, more or less, basal three segments of dorsum of abdomen of female. Margins of connexiva orange. Venter blue-gray to gray-black; venter of last abdominal segment black beneath. Genital segments orange to brown beneath. Base of antennae, margins of all acetabulae, anterior and posterior trochanters, all coxae, and base of anterior femora orange. Wings brown; veins darker at base becoming inconspicuous on apical one half of wing.

Structural characteristics: Dorsum of apterous female narrow after first three segments; connexiva of apterous female reflexed for last four segments. *Apterous male:* anterior trochanter unarmed, or with agglutinated brown hairs sometimes resembling feeble spine. Anterior tibia only slightly dilate and somewhat excavate on apical one half. Pronotum slightly carinate down middle; broadly rounded behind (L. 72, W. 84); occasionally exposing apex of mesonotum. Metanotum short on midline (L. 8, W. 87). Proportions of antennae: Seg. I: II: III: IV:: 73: 45: 44: 35; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 160: 115: 54: 65; of posterior legs: 130: 115: 15: 28. Abdomen tapers evenly to apex. Connexiva semivertical. Venter without median carina. Sparsely scattered, minute, conical, black setae on base of jugum of head, inner margin of proepisternum, and in row along posterior margin at sides of venter of last abdominal segment. Venter of last abdominal segment flattened beneath, somewhat excavate on posterior one half; flattened median portion bounded at sides by more or less distinct ridges which usually bear a hairy prominence at approximately middle of segment. Posterior trochanter armed with five or six small, brown teeth. Posterior femur moderately incrassate (L. 130, W. 30); armed on basal one third with a row of short, closely-spaced spines, and just before middle with one long spine followed by nine or ten shorter, gradually decreasing spines to apex; also armed with an anterior row of inconspicuous spines on apical one half. Posterior tibia straight; armed within with one row of teeth with those at apical one fourth sometimes stouter; also armed with slender spur at apex. *Apterous female:* anterior tibia flattened within on apical one third, and not dilate. Pronotum broadly rounded at apex; depressed in center of posterior margin (L. 70, W. 88); mesonotum emarginate on midline, protruding slightly (L. 8) from under pronotum on each side of midline. Metanotum short on midline (L. 10, W. 89). Proportions of antennae: 70: 40: 38: 34; of intermediate legs: 143: 100: 50: 62; of posterior legs: 120: 118: 15: 27. Dorsum of abdomen narrow after first three segments. Connexiva with group of long brown hairs at apex of second segment; reflexed over dorsum of abdomen for last four segments; apices of connexiva diverging over last abdominal segment. Intermediate femur dorsoventrally flattened. Posterior trochanter unarmed. Posterior femur only slightly incrassate (L. 120, W. 18); armed just before apical one third with one long spine followed by four or five much smaller, rapidly decreasing spines to apex. Posterior tibia straight; armed within with inconspicuous teeth with those on basal one half stouter, also armed with slender spur at apex. *Winged forms:* proportions and armature similar to apterous forms. *Winged male:* Venter of last segment of abdomen formed as in apterous male. Pronotum produced into short (L. 10) process at apex. *Winged female:* pronotum with variable apex. Three types can be found: (1) as in winged male with only short process, (2) with long, bent process swollen at apex (L. 37), or (3) with long bent process with tip expanded and emarginate on midline (L. 40).

Comparative notes: This species is closely related to *R. obesa* Uhler. The males of *R. distincta* Champion can be separated from the males of *R. obesa* Uhler by the differently formed venter of the last abdominal segment which is slightly raised on the midline with a depression each side in *R. obesa* Uhler, while in *R. distincta* Champion that segment is flattened beneath with carinate ridges at the sides. The apterous females can be separated by the apices of the connexiva which are diverging and rounded in *R. distincta* Champion while contiguous and produced into short knoblike processes in *R. obesa* Uhler. So far as is known the winged females of *R. obesa* Uhler always have the apex of the pronotum produced into a long process swollen at the apex and deeply emarginate, while the pronotum can be formed in any of three ways in *R. distincta* Champion. Type 2 (see under structural characteristics; winged female) is by far the most common type in *R. distincta* Champion. The types of apices to the pronotum are found mixed in many long series. Type 1 and type 2 occur in the same series, and type 2 and type 3 occur together. In no case has there been found characters on the apterous forms or on the winged males which would allow separation into groups to correspond to the different types of winged females.

The varieties of *R. distincta arizonensis* Gould, *R. distincta cadyi* Gould, *R. distincta harmonia* Gould, *R. distincta modesta* Gould, *R. distincta proxima* Gould, and *R. distincta valentina* Gould, are indistinguishable from *R. distincta* Champion.

Data on types: This species was described from specimens from Mexico. Champion's type material is located in the British Museum.

Data on distribution: Recorded from Southwestern United States and Mexico. Specimens have been examined from the following localities (new distribution for major political areas are indicated with an asterisk):

* GUATEMALA: Trib. de las Vacas, Guatemala City, IV-4-47, M. Holloway (U. S. National Museum Collection), 12 apterous males, 2 apterous females; 1 km. S. Palin, IV-13-47, R. R. Miller (U. S. National Museum Collection), 1 apterous male, 1 winged male, 1 apterous female; Río Momostenango, 2 mi. E. Momostenango, III-31-47 (U. S. National Museum Collections), 1 apterous male, 1 winged male, 1 apterous female, 2 winged females; Agua Caliente, 28-1-05 (J. R. de la Torre-Bueno Collection), 1 apterous female, 1 winged female.

* HONDURAS: Tegucigalpa, VII-18-18, F. J. Dyar Coll. (U. S. National Museum Collections), 1 apterous male, 1 apterous female.

MEXICO: *Chihuahua:* San Pedro Río, between Chihuahua and Naica, 6-22-34, Smith and Dunkle, 7 apterous males, 20 winged males, 2 apterous females, 19 winged females; San Antonio, 7-15-27, R. H. Beamer (Type series of *R. distincta modesta* Gould), 19 apterous males, 1 winged male, 9 apterous females, 1 winged female.

Distrito Federal: Xochimilco, June 21, 1934, H. E. Hinton, 40 apterous males, 16 winged males, 16 apterous females, 19 winged females.

Guerrero: Puente de Ixtla, 7-12-37, H. D. Thomas, 17 apterous males, 15 winged males, 14 apterous females, 7 winged females.

Hidalgo: Durango, July 28, 1938, H. D. Thomas, 19 apterous males, 1 winged male, 17 apterous females, 4 winged females; Durango, Sept. 24, 1938, H. D. Thomas, 11 apterous males, 1 winged male, 17 apterous females, 2 winged females; San Antonio, near El Salto, 5000 ft. a.s.l., semi-tropical, June 10, 1937, M. Embury, 11 winged males, 5 winged females.

Jalisco: Mazatepec, IV-29-44, J. G. Shaw, 23 apterous males, 4 winged males, 44 apterous females, 5 winged females.

México: Real de Arriba, Alt. 1960 mtrs. May-June, 1933, H. E. Hinton, 23 apterous males, 74 winged males, 20 apterous females, 82 winged females; Progreso Industrial, 2300 m.a.s.l., in brook, Feb. 12, 1933, A. Dampf, 2 apterous males, 2 winged males, 5 apterous females, 2 winged females.

Michoacán: Morelian, 9-4-38, H. D. Thomas, 11 apterous males, 2 winged males, 11 apterous females; 20 mi. E. Zitacuaro, IX-19-38, H. D. Thomas, 8 apterous males, 6 winged males; El Sabino, Uruapan, 7-10-36, H. D. Thomas, 91 apterous males, 101 apterous females; Tancitar, Alt. 6586 ft., Perm. Pool, VIII-8-40, F. Schacht, 63 winged males, 48 winged females.

Morelos: 7-14-36, H. D. Thomas, 8 apterous males, 2 winged males, 4 apterous females, 2 winged females; Cuernavaca, 7-8-36, H. D. Thomas, 2 apterous males, 2 apterous females, 3 winged females; Cuernavaca, April 15, 1946, J. & D. Pallister (U. S. National Museum Collection), 7 apterous males, 4 apterous females; Cuernavaca, 10-5-36, H. D. Thomas, 18 apterous males, 3 winged males, 10 apterous females.

Nuevo León: Ville Santiago, Alt. 2000 ft., Aqueduct pool, VI-18-40, F. Schacht, 4 winged males, 3 apterous females, 3 winged females; Galeana, VII-30-39, H. Heogstraal, 16 apterous males, 8 winged males, 5 apterous females, 1 winged female; Galeana, VII-8-39, H. Heogstraal, 8 apterous males, 14 winged males, 2 apterous females, 3 winged females; Ville de Santiago, VIII-8-39, H. Heogstraal, 8 apterous males, 6 winged males, 3 apterous females, 5 winged females.

Oaxaca: Oaxaca, 5000 ft., semi-desert, Irrig. ld., semi-tropical, Aug. 20, 1937, M. Embury, 13 apterous males, 2 winged males, 2 apterous females; Oaxaca, Aug. 25, 1937, H. D. Thomas, 22 apterous males, 3 winged males, 8 apterous females, 1 winged female.

Puebla: Tehuacán, July 19-25, 1937, H. D. Thomas, 29 apterous males, 2 winged males, 8 apterous females, 4 winged females.

Vera Cruz: Orizaba, July 30, 1937, H. D. Thomas, 14 apterous males, 2 winged males, 10 apterous females, 2 winged females.

UNITED STATES: *Arizona:* Shinono Creek, 1000 ft. above mouth Grand Canyon, 9-3-23, R. C. Moore (type series *R. distincta arizonensis* Gould), 37 apterous males, 12 winged males, 42 apterous females, 8 winged females; Oak Creek Cn., 8-9-32, R. H. Beamer, 19 apterous males, 1 winged male, 15 apterous females; Huachuca Mts., 7-8-32, R. H. Beamer, 16 winged males, 27 winged females; Huachuca, 5-27-37, W. Benedict, 6 winged males, 10 winged females; Granite Dells, 7-12-47, L. D. Beamer, 4 apterous males, 8 apterous females; Baboquivari Mts., 7-18-32, R. H. Beamer, 8 winged males, 8 winged females; Cottonwood River, 7-12-47, A. C. Michener, 7 apterous males; Oak Creek Canyon, 7-15-47, L. D. Beamer, 8 apterous males, 7 apterous females; Grand Canyon, 8-11-27, P. A. Readio (type series of *R. distincta harmonia* Gould), 2 apterous males, 4 apterous females; Janez Springs, VII-1-41, R. H. Beamer, 2 apterous males; Santa Rita Mts., 7-17-32, R. H. Beamer, 2 winged males, 1 winged female; Sabino Canyon, XII-20-41, H. B. Hungerford, 3 apterous males, 4 apterous females; Chiricahua Mts., 7-8-32, R. H. Beamer, 3 winged females.

California: San Diego Co. 7-7-29, L. D. Anderson, 5 apterous males, 1 winged male, 32 apterous females, 1 winged female. San Diego Co., 7-4-29, P. W. Oman, 31 apterous males, 5 winged males, 39 apterous females, 1 winged female; San Diego Co., 7-28-29, P. W. Oman, 9 apterous males, 3 winged males, 24 apterous females; San Diego Co., 7-4-29, L. D. Anderson, 6 apterous females; San Diego Co., 7-4-29, R. H. Beamer, 1 apterous male, 4 apterous females; Dulzura, 8-9-35, R. H. Beamer, 45 apterous males, 54 apterous females; Dulzura, 8-9-35, Jack Beamer, 20 apterous males, 33 apterous females; India, 7-24-29, L. D. Anderson, 39 apterous males, 41 apterous females, 1 winged female; Lemon Cove, 7-24-29, R. H. Beamer, 15 apterous males, 15 apterous females; Lemon Cove, 7-26-29, L. D. Anderson, 12 apterous males, 1 winged male, 19 apterous females; Campo, VII-18-40, L. C. Kuitert, 34 apterous males, 33 apterous females; Lene, 8-19-38, R. I. Sailer, 12 apterous males, 15 apterous females; Nipomo, 7-28-35, R. H. Beamer, 19 apterous males, 8 apterous females; Arroyo, Seca R. 8-8-38, R. I. Sailer, 5 apterous males, 4 apterous females; Palm City, 8-7-35, R. H. Beamer, 2 apterous males; Fresno, June 20, 1926, C. J. Drake, 1 apterous male, 1 apterous female; Jacumba, VII-17-40, L. C. Kuitert, 1 apterous male, 3 winged males, 2 apterous females, 1 winged female; Pine Valley, 7-27-36, D. W. Craik, 12 apterous males, 2 winged males, 25 apterous females; Pine Valley, 7-27-36, R. I. Sailer, 4 apterous males, 2 winged males, 3 apterous females; Winters, Aug. 6, 1928, R. H. Beamer, 4 apterous males, 1 winged male, 13 apterous females, 1 winged female; Pacific, VIII-9-40, L. C. Kuitert, 8 apterous males, 13 apterous females.

Colorado: Grand Junction, 8-15-36, M. B. Jackson, 14 apterous males, 33 apterous females; N. W. Colorado, Aug. 25, 1920, R. C. Moore, 12 apterous males, 27 apterous females; Dolores, Aug. 15, 1925, C. J. Drake (paratypes of *R. excellentis* Drake and Harris), 4 apterous males, 1 apterous female; Boulder Creek, 8-16-25, Beamer & Lawson (type series of *R. distincta proxima* Gould), 11 apterous males, 5 winged males, 9 apterous females, 3 winged females; Craig, VIII-18-40, L. C. Kuitert, 30 apterous males, 9 apterous females.

New Mexico: Las Cruces, 1925, C. B. Lebert, 1 apterous male, 1 apterous female.

Texas: Ft. Davis, 6-20-47, L. D. Beamer, 6 apterous males, 2 apterous females; Valentine, July 13, 1927, R. H. Beamer (type series of *R. distincta valentina* Gould), 43 apterous males, 34 apterous females; Jeff Davis, 7-19-33, 7 apterous males, 1 winged male, 2 apterous females; Austin, 4-01 (J. R. de la Torre-Bueno Collection), 3 apterous males, 1 apterous female.

Utah: Zion Canyon, 4600 ft., Oct. 1, 1934, Bryant, 1 apterous male, 5 apterous females; Vernal, 8-2-47, R. E. Elbel, 7 apterous males, 8 apterous females.

Wyoming: North Platte, Sept. 2, 1926, G. Cady (type series of *R. distincta cadyi* Gould), 59 apterous males, 60 apterous females.

Rhagovelia knighti Drake and Harris

(Pl. VII, fig. 5)

1927. *Rhagovelia knighti* Drake and Harris, Proc. Biol. Soc. Washington, vol. 40, p. 133.
1931. *Rhagovelia knighti,* Gould, Kansas Univ. Sci. Bull., vol. 20, p. 35 (redescribes).
1933. *Rhagovelia knighti,* Gould, Ann. Ent. Soc. America, vol. 26, p. 468 (records from Arkansas).

Size:	*Length*	*Width*
	3.65 mm. apterous male	1.16 mm. apterous male
	3.73 mm. apterous female	1.33 mm. apterous female

Color: General color black, clothed with golden pubescence. Anterior band of pronotum interrupted at middle; orange behind vertex of head, becoming pruinose behind eyes. Dorsum of all abdominal segments and metanotum with median, black, shining spots in male; female with last three segments of dorsum of abdomen occasionally so marked. Margins of connexiva orange. Venter blue-gray. Last segment of venter of abdomen orange to brown. Base of antennae, margins of all acetabulae, anterior and posterior coxae, all trochanters, and base of anterior femur yellow to orange.

Structural characteristics: Dorsum of abdomen of apterous female narrow after first three segments; connexiva of apterous female reflexed for last four segments. *Apterous male:* anterior trochanter armed only with group of agglutinated brown hairs which may resemble a spine. Anterior tibia flattened within; not dilate. Pronotum indistinctly carinate; rounded or somewhat triangular behind (L. 59, W. 67). Mesonotum usually somewhat exposed. Metanotum short on midline (L. 7, W. 70). Proportions of antennae: Seg. I: II: III: IV:: 56: 33: 36: 33; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 132: 90: 40: 53; of posterior legs: 100: 85: 10: 22. Abdomen tapers evenly to apex. Connexiva semivertical. Venter without median carina. Venter of last segment of abdomen depressed on each side of a median, somewhat triangular, anterior area. Sparsely scattered, minute, black, conical setae on proepisternum, or seemingly absent. Posterior trochanter armed with eight to ten small teeth. Posterior femur moderately incrassate (L. 100, W. 27); armed with row of small teeth on basal two fifths, and with one long spine at basal two fifths followed by eight or nine smaller, gradually decreasing spines to apex; also armed with inconspicuous row of small spines anterior to main armature. Posterior tibia straight; armed within with equal teeth and slender spur at apex. *Apterous female:* pronotum broadly rounded behind; slightly depressed on posterior one fourth (L. 64, W. 75). Posterior margin of mesonotum broadly emarginate behind. Metanotum longer than in male (L. 10, W. 85). Proportions of antennae: 57: 34: 37: 35; of intermedite legs: 122: 84: 44: 56; of posterior legs: 97: 95: 13: 25. Dorsum of abdomen narrowed after first three segments. Connexiva reflexed over abdomen on last four segments, nearly touching or touching at apex; produced at apex into short, knoblike processes which are elevated less than the length of tarsal segment II of intermediate leg above dorsum of first genital segment. Minute, conical, black setae as in male. Intermediate femur dorso-ventrally flattened from basal one fourth to apical one fourth. Posterior trochanter unarmed. Posterior femur not as incrassate as in male (L. 97, W. 16); armed at apical two fifths with one long spine followed by three or four much shorter, inconspicuous spines to apex. Posterior tibia unarmed except for inconspicuous spur at apex. *Winged forms:* unknown.

Comparative notes: This species resembles *R. obesa* Uhler. The apterous female of *R. knighti* Drake and Harris can be separated from *R. obesa* Uhler by the lack of the tumid abdominal segments, and by the extent of the apical processes of the connexiva which are much shorter and closer to the dorsum of the first genital segment in *R. knighti* Drake and Harris; the males can be separated by the less exposed mesonotum which is only partly exposed in *R. knighti* Drake and Harris whereas the mesonotum of the male of *R. obesa* Uhler is generally exposed and approximately equal in length with the metanotum.

Data on types: Holotype, apterous male; allotype, apterous female; paratypes, several apterous males and females; all taken at Hollister, Missouri, Sept. 5-10, 1925, H. H. Knight, collector. The holotype, allotype, and several paratypes are in the personal collection of Dr. C. J. Drake. Paratypes are also in the collection of H. H. Knight, Iowa State College, and the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on distribution: Recorded only from Missouri and Arkansas. In addition to the paratypes, specimens have been examined from the following localities (new distribution records for major political areas are indicated with an asterisk):

UNITED STATES: *Arkansas:* Scott Co., 8-23-28, R. H. Beamer, 2 apterous males, 3 apterous females; Carroll Co., 9-17-32, G. E. Gould, 2 apterous males, 2 apterous females; Sharpe Co., 9-14-32, G. E. Gould, 1 apterous male, 1 apterous female; Polk Co., 8-21-28, R. H. Beamer, 2 apterous males, 3 apterous females.

Missouri: Barton Co., 9-17-32, G. E. Gould, 1 apterous male, 2 apterous females; Jasper Co., 9-17-32, G. E. Gould, 1 apterous male.

* *Oklahoma:* Ottawa Co., Dev. Promenade, 9-21-32, L. D. Tuthill, 10 apterous males, 7 apterous females.

Rhagovelia obesa Uhler

(Pl. VII, fig. 6)

1871. *Rhagovelia obesa* Uhler, Proc. Boston Soc. Nat. Hist., vol. 14, p. 107.
1878. *Rhagovelia obesa,* Uhler, Proc. Boston Soc. Nat. Hist., vol. 19, p. 434 (amplifies original description).
1884. *Rhagovelia obesa,* Uhler, *in* Kingsley's Natural History, vol. 2, p. 260.
1886. *Rhagovelia obesa,* Uhler, Check List Hemip., p. 18.
1894. *Rhagovelia obesa,* Uhler, Proc. Zool. Soc. London, p. 215.
1894. *Rhagovelia obesa,* Uhler, California Acad. Sci., ser. 2, vol. 4, p. 258 (probably should refer to *R. distincta*).
1896. *Rhagovelia obesa,* Lethierry and Severin, Cat. Gén. des Hémip., vol. 3, p. 55.
1898. *Rhagovelia obesa,* Champion, Biol. Centr. Amer. Het., vol. 2, p. 135 (gives as closely related to *R. distincta*).
1901. *Rhagovelia obesa,* Kirkaldy, Ent., vol. 34, p. 308.
1907. *Rhagovelia obesa,* Torre-Bueno, Canadian Ent., vol. 39, p. 61 (good on biology).

1910. *Rhagovelia obesa,* Banks, Cat. of Nearctic Hemip.-Heter., p. 28.
1911. *Rhagovelia obesa,* Van Duzee, Check List Hemip.
1917. *Rhagovelia obesa,* Van Duzee, Cat. of Hemip. of America N. of Mexico, p. 435.
1919. *Rhagovelia obesa,* Hungerford, Kansas Univ. Sci. Bull., vol. 11, p. 128 (quotes Uhler's 1878 description).
1922. *Rhagovelia obesa,* Parshley, S. Dakota St. Col. Tech. Bull., vol. 2, p. 20 (compares to *R. oriander*).
1923. *Rhagovelia obesa,* Torre-Bueno *in* Connecticut Geo. and Nat. Hist. Survey Bull., vol. 34, p. 418 (gives distribution as N. E. United States).
1924. *Rhagovelia flavicincta* Torre-Bueno, Trans. American Ent. Soc., vol. 50, p. 249 (describes from North Carolina).
1924. *Rhagovelia arctoa* Torre-Bueno, Trans. American Ent. Soc., vol. 50, p. 250 (describes from Minnesota).
1925. *Rhagovelia obesa,* Torre-Bueno, Trans. American Ent. Soc., vol. 50, p. 250 (redescribes).
1925. *Rhagovelia obesa,* Hussey, Jour. New York Ent. Soc., vol. 33, p. 63 (compares with *R. choreutes*).
1926. *Rhagovelia flavicincta,* Blatchley, Heter. of East. N. America, p. 998 (redescribes).
1926. *Rhagovelia obesa,* Blatchley, Heter. of Eastern N. America, p. 996 (redescribes).
1927. *Rhagovelia obesa,* Drake and Harris, Proc. Biol. Soc. Washington, vol. 40, p. 131 (suggest synonomy of *R. arctoa* and *R. flavicincta* with *R. obesa*).
1928. *Rhagovelia obesa,* Torre-Bueno, Cornell Univ. Memoir 101.
1931. *Rhagovelia obesa,* Gould, Kansas Univ. Sci. Bull., vol. 20, p. 36 (redescribes).
1931. *Rhagovelia flavicincta,* Gould, Kansas Univ. Sci. Bull., vol. 20, p. 31 (redescribes, records from Virginia).
1931. *Rhagovelia arctoa,* Gould, Kansas Univ. Sci. Bull., vol. 20, p. 16 (redescribes, records from Michigan, and Ontario, Canada).
1933. *Rhagovelia obesa,* Gould, Ann. Ent. Soc. America, vol. 26, p. 469 (records from Indiana).
1936. *Rhagovelia flavicincta,* Coker, Millsap and Rice, Bull. Brooklyn Ent. Soc., vol. 31, p. 84 (excellent discussion of the function of the swimming plume of the intermediate leg).

Size:	*Length*	*Width*
	3.75 mm. apterous male	1.13 mm. apterous male
	3.73 mm. apterous female	1.33 mm. apterous female
	4.00 mm. winged male	1.53 mm. winged male
	4.55 mm. winged female	1.62 mm. winged female

Color: General color black, clothed with golden pubescence. Anterior band of pronotum interrupted at middle; orange behind vertex of head becoming pruinose behind eyes. Dorsum of male with black shining spots on all abdominal segments, on metanotum and usually a spot on each side of midline of mesonotum; dorsum of female pruinose black with occasionally indefinite black shining areas on some of basal abdominal segments. Margins of connexiva orange. Venter blue-gray. Venter of last abdominal segment black beneath. Base of antennae, all acetabulae, anterior and posterior coxae, all trochanters, and basal one fifth to one half of anterior femur yellow to orange.

Structural characteristics: Dorsum of abdomen of apterous female narrow after first three segments, connexiva reflexed for apical four segments. *Apterous male:* anterior trochanter armed only with group of agglutinated hairs which may resemble a spine, but which can be easily rubbed off. Anterior tibia flattened within; not dilate. Pronotum inconspicuously carinate on midline; rounded behind (L. 53, W. 62). Mesonotum exposed; usually somewhat truncate at apex (L. 12, W. 64); metanotum short on midline (L. 7, W. 72). Proportions of antennae: Seg. I: II: III: IV:: 56: 32: 34: 32; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 130: 93: 48: 52; of posterior legs: 100: 83: 12: 20. Abdomen tapers evenly to apex. Connexiva semivertical. Venter without median carina. Venter of last segment of abdomen depressed on each side of midline beneath. Minute, black, conical setae not conspicuous if present. Posterior trochanter armed with several dark teeth. Posterior femur somewhat incrassate (L. 100, W. 21); armed on basal one half with row of small, inconspicuous spines; armed just before middle with one long spine followed by eight or ten smaller, gradually decreasing spines to apex; also armed on apical one half with inconspicuous row of smaller spines anterior to main row of spines. Posterior tibia straight and armed within with small, regular teeth and spur at apex. *Apterous female:* anterior trochanter without agglutinated hairs resembling a spine. Pronotum almost straight to slightly emarginate on midline at apex; depressed on midline on posterior one third (L. 60, W. 80). Mesonotum somewhat flattened in center, becoming tumid toward sides; broadly emarginate on midline at apex (L. 8, W. 81). Metanotum (L. 13, W. 84) and first two abdominal segments noticeably swollen. Proportions of antennae: 56: 31: 33: 32; of intermediate legs: 125: 90: 45: 57; of posterior legs: 98: 95: 12: 22. Dorsum of abdomen narrowed after first three segments. Connexiva usually with group of brown hairs at apex of second segment; reflexed for last four segments; usually contiguous at apex; prolonged into spinelike points at apex, these points standing well above dorsum of first genital segment (height, 16). Abdomen usually bent upward at an angle of 25 degrees. Intermediate femur dorso-ventrally flattened from basal one fourth to apical one fourth. Posterior trochanter unarmed. Posterior femur only slightly incrassate (L. 98, W. 16); armed at apical one third with one small spine followed by five or six much smaller, gradually decreasing spines to apex. Posterior tibia apparently unarmed except for spur at apex. *Winged forms:* proportions and armature similar to apterous forms. Wings just cover apex of genital segments. *Winged male:* venter formed as in apterous male. Pronotum triangular behind (L. 110, W. 103), not produced into spinelike process. *Winged female:* pronotum produced at apex into long process which is abruptly expanded and deeply emarginate at apex (L. 25).

Comparative notes: This species resembles *R. knighti* Drake and Harris. The females of *R. obesa* Uhler can be separated from those of *R. knighti* Drake and Harris by the curved first two segments of the connexiva, which in *R. knighti* Drake and Harris are straight, also the swollen condition of the dorsum of the first two abdominal segments in *R. obesa* Uhler will serve to separate the females. The males of the two species can be separated by the reduced condition of the spines on the basal one third of the posterior femur which in *R. obesa* Uhler number six to eight, and are small, widely-spaced spines; the spines on the base of the femur of *R. knighti* Drake and Harris number from 12 to 16 closely-spaced spines which are variable in size but always in a closely-packed row.

R. arctoa Bueno and *R. flavicincta* Bueno are indistinguishable from *R. obesa* Uhler. The spine on the anterior trochanter of the male is formed from agglutinated hairs which easily become broken, and the color variations are no more than would be expected from a widely distributed species. Therefore, the names *R. arctoa* Bueno and *R. flavicincta* Bueno become synonyms of the name *R. obesa* Uhler.

Data on types: This species was described from specimens from Massachusetts. Uhler's type material is in the United States National Museum.

Data on distribution: Recorded from Ontario, Canada and the following states of the United States: California (*R. distincta* [?]), Colorado (*R. distincta* [?]), District of Columbia, Florida (*R. choreutes* [?]), Illinois, Indiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, New Jersey, New York, North Carolina, Pennsylvania, South Carolina, Tennessee, Utah (*R. distincta* [?]), Vermont, and Virginia. Specimens from the following localities have been examined (new distribution records for major political units are indicated with an asterisk):

UNITED STATES: * *Alabama:* Burnsville, 7-20-30, R. H. Beamer, 6 apterous males, 17 apterous females, 2 winged females.

* *Georgia:* Perry, 8-12-39, J. D. Beamer, 10 apterous males, 7 apterous females; Macon, 7-25-30, Paul W. Oman, 27 apterous males, 14 apterous females.

Maryland: Lalseland, 9-12-31, P. W. Oman, 7 apterous males, 1 winged male, 2 apterous females, 1 winged female; Beltsville, 9-25-32, P. W. Oman, 30 apterous males, 50 apterous females, 1 winged female.

Michigan: Lake Gogebic, 8-18-37, R. H. Beamer, 28 apterous males, 9 apterous females; Iosco Co., Aug. 22, 03, E. H. Frothingham (J. R. de la Torre-Bueno Collection), 1 apterous male, 1 apterous female; Cheboygan Co., 8-2-37, H. B. Hungerford, 4 apterous males, 6 apterous females; Cheboygan Co., 1935, M. Sanderson, 2 apterous males, 2 apterous females; Cheboygan Co., 7-16-39, H. B. Hungerford, 3 apterous males, 1 apterous female; Cheboygan Co., 7-15-42, E. L. Todd, 3 apterous males, 2 apterous females; Douglas Lake, 7-23-27, H. B. Hungerford, 1 apterous male, 4 apterous females; Douglas Lake, 7-24-27, H. B. Hungreford, 3 apterous males, 9 apterous females.

Minnesota: Cook Co., L. Devil Track Cr., Aug. 11, 1922, H. B. Hungerford, 52 apterous males, 60 apterous females; Cook Co., L. Devil Track Cr., Aug. 11, 1922, H. B. Hungerford (type series of *R. arctoa* Bueno, in part), 11 apterous males, 2 apterous females; H. B. Hungerford, 9 apterous males, 6 apterous females; Cook Co., Little Devil Track Cr., Aug. 12, 1922, Wm. E. Hoffman (paratypes of *R. arctoa* Bueno, in part), 3 apterous females; Bengal, Aug. 18, 1922, Wm. E. Hoffman (paratypes of *R. arctoa* Bueno, in part), 3 apterous males, 1 apterous female; Bengal, Aug. 18, 1922, Wm. E. Hoffman (J. R. de la Torre-Bueno Collection), 9 apterous males, 7 apterous females.

North Carolina: Northampton Co., 15 Sept. 1929, G. E. Gould, 6 apterous males, 4 apterous females; Raleigh, Oct. 20, 1920, C. S. Brimsley (J. R. de la Torre-Bueno Collection, paratypes of *R. flavicincta* Bueno, in part), 1 apterous male, 3 apterous females; Swannanoa, Oct. 5, 1915, R. W. Leiby (J. R. de la Torre-Bueno Collection, paratypes of *R. flavicincta* Bueno in part), 4 apterous females; Raleigh, Oct. 13, 1915, R. W. Leiby, 3 apterous males.

* *New Hampshire:* Glen, 8-20-34, P. M. McKinstry, 108 apterous males, 70 apterous females.

New Jersey: Rahway, R., Cranford, 6-8-04, (J. R. de la Torre-Bueno Collection), 9 apterous males, 1 winged male, 8 apterous females, 1 winged female; Lakehurst, 5-9-03, (J. R. de la Torre-Bueno Collection), 3 apterous females; Glen Ridge, 23-4-06, (J. R. de la Torre-Bueno Collection), 2 apterous males, 2 apterous females.

New York: Staten Id. 9-7-05, (J. R. de la Torre-Bueno Collection), 14 apterous males, 7 apterous females; Ithaca, 1917, H. B. Hungerford, 4 apterous males, 4 apterous females; Niagara; 8-9-05, (J. R. de la Torre-Bueno Collection), 2 apterous males, 2 apterous females; White Plains, 5-9-20, Bueno (J. R. de la Torre-Bueno Collection) 1 apterous female; Nepperham, 30-9-05 (J. R. de la Torre-Bueno Collection), 2 apterous females.

Ohio: Columbus, 10-9-15, C. J. Drake (J. R. de la Torre-Bueno Collection), 1 winged male.

Pennsylvania: Dingmans Fry, 8-20-46, L. D. Beamer, 8 apterous males, 8 apterous females.

South Carolina: Batesburg, 8-24-30, P. W. Oman, 20 apterous males, 27 apterous females; Tigerville, 8-26-30, P. W. Oman, 26 apterous males, 9 winged males, 17 apterous females, 7 winged females; Batesburg, 8-24-30, P. W. Oman, 74 apterous males, 70 apterous females, 1 winged female.

Tennessee: Coal Creek, 8-27-30, P. W. Oman, 8 apterous males, 10 apterous females; Coal Creek, 8-27-30, J. Nottingham, 16 apterous males, 17 apterous females; Clarksville, July 15, 1939, E. G. Wegenek, 8 apterous males, 3 apterous females; Clarksville, July 12, 1939, J. D. Beamer, 7 apterous males, 1 apterous female; Elk Valley, 8-27-30, P. W. Oman, 2 apterous males.

Vermont: Springfield, 8-22-34, P. McKinstry and M. Griffith, 48 apterous males, 86 apterous females.

Virginia: Brunswick Co., Sept. 15, 1929, George E. Gould and Thelma Gould, 4 apterous females; Warrenton, Aug. 21, 1947, Shirley Bacon, 3 apterous males, 2 apterous females.

Rhagovelia oriander Parshley

(Pl. VII, fig. 7)

1922. *Rhagovelia oriander* Parshley, S. Dakota State Ent. Tech. Bull., vol. 2, p. 19.

1923. *Rhagovelia oriander*, Torre-Bueno, *in* Connecticut Geo. & Nat. Hist. Survey Bull., vol. 34, p. 418 (mentions possible occurrence in Connecticut).

1925. *Rhagovelia oriander*, Torre-Bueno, Trans. American Ent. Soc., vol. 50, p. 250 (redescribes).

1925. *Rhagovelia oriander*, Hussey, Jour. New York Ent. Soc., vol. 33, p. 69 (records some variations from Bueno's redescription).

1926. *Rhagovelia oriander*, Blatchley, Het. of East. N. America, p. 999 (redescribes, records from Indiana and Illinois).

1927. *Rhagovelia oriander*, Drake and Harris, Proc. Biol. Soc. Washington, vol. 40, p. 131 (describes winged forms; record from Ohio, Iowa, South Dakota and Minnesota).

1931. *Rhagovelia oriander*, Gould, Kansas Univ. Sci. Bull., vol. 20, p. 38 (gives new record from Kansas, redescribes).

1933. *Rhagovelia oriander,* Gould, Ann. Ent. Soc. America, vol. 26, p. 469 (gives new record from Michigan).

Size:	*Length*	*Width*
	3.59 mm. apterous male	1.13 mm. apterous male
	3.65 mm. apterous female	1.33 mm. apterous female
	3.44 mm. winged male	1.48 mm. winged male
	3.89 mm. winged female	1.63 mm. winged female

Color: General color brown-black, clothed with golden pubescence. Pronotum with interrupted orange band behind vertex of head becoming pruinose behind eyes. Median area of dorsum of all abdominal segments of male shining brown-black only last one or two of female shining brown-black. Margins of connexiva orange. Venter blue-gray. Venter of last abdominal segment black beneath. Base of antennae, margins of all acetabulae, anterior and posterior coxae, all trochanters and base of anterior femora yellow. Wings dark brown-black.

Structural characteristics: Dorsum of abdomen of apterous female narrow after first three segments, connexiva reflexed for apical four segments. *Apterous male:* anterior trochanter armed with brown spine. Anterior tibia flattened within for apical two thirds, and not dilate. Pronotum with posterior margins almost straight, angulate at apex (L. 67, W. 71); mesonotum covered by pronotum on median line, but exposed at sides; metanotum partially (½) covered by apex of pronotum. Proportions of antennae: Seg. I: II: III: IV:: 54: 32: 37: 33; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 124: 90: 45: 53; of posterior legs: 100: 85: 11: 24. Abdomen tapers evenly at first, angle of taper increasing on last three segments. Venter without median carina. Posterior trochanter armed with approximately eight small teeth. Posterior femur moderately incrassate (L. 100, W. 23); armed on basal half with row of small spines, armed at middle with one long, slender spine followed by five or ten smaller, gradually decreasing spines to apex; also armed with an anterior row of very small spines on apical one half. Posterior tibia straight; armed within with one row of closely set teeth which become slightly stouter toward apex; armed at apex with small spur. *Apterous female:* anterior trochanter unarmed; anterior tibia as in male. Pronotum with apex produced into a long (L. 24), knobbed process elevated at an angle of approximately thirty degrees; longer than wide (L.—to tooth under apical process —93, W. 82); mesonotum exposed at sides of pronotum. Metanotum and first abdominal segment covered by apex of pronotum. Proportions of antennae: 57: 32: 37: 33; of intermediate legs: 123: 85: 45: 55; of posterior legs: 100: 95: 13: 24. Abdomen broad at first, narrowed on last three segments. Connexiva reflexed tightly against abdomen for last three segments; gradually narrowing and touching at apex or may continue subparallel and not touch at apex. Intermediate femur dorso-ventrally flattened from basal one fourth to just before apex. Posterior trochanter unarmed. Posterior femur less incrassate than that of male, (L. 100, W. 15); armed at apical one third with sharply-bent, long spine followed by approximately seven smaller, decreasing spines to apex. Posterior tibia straight and apparently unarmed except for small spur at apex. *Winged forms:* Wings reaching slightly beyond apex of genital segments. *Winged male:* pronotum acutely triangularly produced at apex, with an inconspicuous median carina. *Winged female:* pronotum produced into a semierect, somewhat cylindrical process.

Comparative notes: The characters of the pronotum serve to separate this species from all known *Rhagovelia.* The angulate pronotum of the male exposing the mesonotum only at the sides, and the pronotum of the apterous female with a knobbed elevated process at the apex serve to separate *R. oriander* Parshley from *R. knighti* Drake and Harris, which it mostly closely resembles.

Data on types: Holotype, apterous male; allotype, apterous female; numerous male and female paratypes. The type series was collected at Brookings, South Dakota, 7-8-21, by H. C. Severin. The holotype, allotype and many paratypes are in Parshley's personal collection. Paratypes are also in the collections of the South Dakota State Agricultural Experiment Station and Torre-Bueno's collection (now in the Francis Huntington Snow Entomological Collections, University of Kansas). Morphotypes and paramorphotypes are males and females taken at Rockbridge, Hocking Co., Ohio, July 7, 1916, and are in the personal collection of Dr. C. J. Drake.

Data on distribution: Recorded only from the United States. States having records of occurrence of this species are South Dakota, Indiana, Illinois, Ohio, Iowa, Minnesota, Kansas and Michigan. In addition to the two paratypes the following specimens have been examined:

UNITED STATES: *Illinois:* Chicago, New Lenox, 23-VII-27, H. M. Parshley, 1 apterous male, 1 apterous female; Piatt Co., 4-25-32, Geo. E. Gould, 2 apterous males.

Indiana: Kosciusko Co., Aug. 11, 1932, Geo. E. Gould, 1 apterous male, 1 apterous female; DeKalb Co., Aug. 11, 1932, G. E. Gould, 1 apterous male; Lafayette, 1-Oct.-1931, 1 apterous male, 1 apterous female; Warren Co., Aug. 28, 1932, G. E. Gould, 1 apterous female; Parke Co., Aug. 28, 1932, G. E. Gould, 1 apterous male; Lafayette, 26-Sept.-31, 1 apterous male, 1 apterous female; White Co., July 25, 1932, G. E. Gould, 1 apterous male; Montgomery Co., Aug. 1932, G. E. Gould, 1 apterous female; Howard Co., Oct. 23, 1932, G. E. Gould, 1 apterous male.

Kansas: Woodbine, Aug. 26, 1925, Beamer and Lawson, 35 apterous males, 42 apterous females.

Michigan: St. Joseph Co., Aug. 7, 1932, G. E. Gould, 1 apterous male.

South Dakota: Brookings, Sept. 27, 1922, H. C. Severin Coll., 1 apterous male, 1 apterous female (labeled "Topotype, *R. oriander* Parsh. by Parshley.").

Rhagovelia rivale Bueno

(Pl. VII, fig. 8)

1924. *Rhagovelia rivale* Torre-Bueno, Trans. American Ent. Soc., vol. 50, p. 247.
1927. *Rhagovelia rivale,* Drake and Harris, Proc. Biol. Soc. Washington, vol. 40, p. 133 (record from Colorado).
1931. *Rhagovelia rivale,* Gould, Kansas Univ. Sci. Bull., vol. 20, p. 40 (redescribes).
1933. *Rhagovelia rivale,* Gould, Ann. Ent. Soc. America, vol. 26, p. 469 (records from Missouri).

Size:	*Length*	*Width*
	3.50 mm. apterous male	1.16 mm. apterous male
	4.32 mm. apterous female	1.33 mm. apterous female
	3.83 mm. winged male	1.53 mm. winged male
	4.75 mm. winged female	1.78 mm. winged female

Color: General color brown to pruinose black, clothed with golden pubescence. Anterior band of pronotum partially interrupted at middle in some cases; orange behind vertex of head becoming pruinose behind eyes. Lateral and posterior margins of pronotum usually orange. Dorsum of abdomen of male with last abdominal segment with rectangular, shining, brown to black area; three or four other abdominal segments may show smaller, irregular, median, shining areas. Dorsum of abdomen of female without median shining areas. Margins of connexiva orange to yellow. Venter blue-gray. Venter of last abdominal segment yellow to orange. Base of antennae, margins of all acetabulae, all coxae and trochanters, and base of anterior femora yellow.

Structural characteristics: Dorsum of abdomen of apterous female narrow after first three segments, connexiva reflexed for apical four segments. *Apterous male:* anterior trochanter armed only with agglutinated hairs which may resemble a spine. Anterior tibia arcuate; not dilate nor excavate. Pronotum sharply rounded at apex: indistinctly carinate on midline (L. 55, W. 64). Mesonotum broadly exposed; truncate at apex (L. 10, W. 66). Metanotum short on midline (L. 7, W. 72). Proportions of antennae: Seg. I: II: III: IV:: 57: 34: 34: 32; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 125: 90: 47: 51; of posterior legs: 93: 92: 10: 22. Abdomen tapering rather evenly to apex, angle of taper increasing for last three segments. Connexiva semivertical. Minute, black, conical setae absent. Venter without median carina. Venter of last abdominal segment shallowly depressed on each side of rather broad, central area on posterior one half. Posterior trochanter unarmed. Posterior femur slightly incrassate (L. 93, W. 15); armed on basal one half with one or two small spines or may be unarmed on basal one half; armed at middle with one slender spine followed by approximately four much smaller, subequal spines to apex. Posterior tibia straight; armed within with subequal teeth and stout spur at apex. *Apterous female:* anterior femur slightly arcuate; anterior tibia straight. Pronotum usually wider than long (L. 73, W. 84) but may vary to subsequal or even longer than wide. Mesonotum tumid; truncate to slightly emarginate at apex (L. 14, W. 84). Metanotum slightly tumid in center and at sides (L. 10, W. 85). Proportions of antennae: 67: 40: 40: 33; of intermediate legs: 155: 103: 56: 57; of posterior legs: 112: 111: 15: 25. Dorsum of abdomen narrow after first three segments. Connexiva reflexed for last four segments; occasionally contiguous over dorsum of abdomen for a few segments and then separating, or may be parallel and not contiguous. Intermediate femur dorso-ventrally flattened from basal one fourth to apical one fourth. Posterior trochanter unarmed. Posterior femur scarcely incrassate (L. 112, W. 16); armed just before apical one third with one long spine followed by three much smaller, subequal spines toward apex. Posterior tibia straight and seemingly unarmed. *Winged forms:* Proportions and armature similar to apterous forms. Wings just cover apex of genital segments. *Winged male:* pronotum continued into short process at apex (L. 10). Venter formed as in apterous male. *Winged female:* pronotum continued into long, cylindrical process which is rounded at apex (L. 35).

Comparative notes: This species resembles *R. obesa* Uhler and *R. knighti* Drake and Harris. *R. rivale* Bueno can be separated from both of those species by the unarmed posterior trochanter in the male, by the tumid mesonotum in the female, and by the lateral and posterior margins of the pronotum being more or less orange. In addition the dorsum of the apterous male has some segments without or at most inconspicuously developed median shining areas.

Data on types: The holotype is an apterous female. Bueno states that the morphotype is a winged female; however the specimen bearing the label "Morphotype, female" is a winged male. Paratypes are 5 apterous males, 1 apterous female, 1 winged male, 1 winged female and 1 nymph. The specimens were all collected at Dykeman's Bridge, Kansas, July 1922, by H. B. Hungerford. The type series is in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on distribution: Recorded from Kansas, Missouri, and Colorado. In addition to the type series, specimens from the following localities have been examined (new distribution for major political areas is indicated with an asterisk):

UNITED STATES: *Colorado:* Wray, Aug. 4, 1925, C. J. Drake, 1 apterous male.

Kansas: Kiowa Co., July 5, 1923, R. H. Beamer, 2 apterous males, 1 apterous female; Wilson Co., 866 ft., 1916, R. H. Reamer, 2 apterous males, 2 apterous females; Neosho Co., 9-20-31, G. E. Gould, 2 apterous males, 1 apterous female; Osborne Co., 1557 ft., Aug. 3, 1912, F. X. Williams, 1 apterous male, 1 apterous female; Marshall Co., 9-25-32, G. E. Gould, 1 apterous male, 1 apterous female; Cloud Co., 9-24-32, G. E. Gould, 2 apterous males, 1 apterous female; Phillips Co., 8-8-25, H. J. Grady, 1 apterous male, 1 apterous female; Riley Co., June 17, Popenoe, 1 apterous male, 1 apterous female; Scott Co., 8-10-25, H. J. Grady, 1 apterous male, 1 apterous female; Republic Co., 7-11-25, R. H. Beamer, 17 apterous males, 26 apterous females; Dykeman's Bridge, July, 1922, H. B. Hungerford, 1 apterous male, 2 apterous females, 1 winged female, 14 nymphs; Dickinson Co., 6-25, C. H. Martin, 5 apterous males, 5 apterous females; Marshall Co., July 13, 1925, R. H. Beamer, 13 apterous males, 13 apterous females.

Missouri: Macon Co., 9-25-32, G. E. Gould, 2 apterous males, 2 apterous females; Linn Co., 9-25-32, G. E. Gould, 1 apterous male, 2 apterous females.

* *Oklahoma:* Ottawa Co., Dev. Promenade, 9-21-32, L. D. Tuthill, 27 apterous males, 2 winged males, 25 apterous females, 2 winged females.

* *Texas:* Kerr Co., 7-20-28, R. H. Beamer, 2 apterous females.

AINSLIEI GROUP

Group characteristics: The ainsliei group can be characterized as consisting of those species of the genus *Rhagovelia* having the dorsum of the abdomen of the apterous female narrow after the first three segments, the intermediate femur of the female dorso-ventrally flattened, and the terminal genital segment prolonged into a sharply-pointed process in both sexes. The winged forms are rather rare; the wings just cover the apex of the genital segments.

The following species comprise this group:

1. *R. ainsliei* Drake and Harris
2. *R. becki* Drake and Harris
3. *R. gracilis* sp. nov.

KEY TO SPECIES OF THE AINSLIEI GROUP

1. Body more than or approximately 4 times as long as wide . . . . *becki*
Body less than or approximately 3.5 times as long as wide 2

2.(1) Terminal spines on connexiva of female large and extending almost back to last genital segment; metasternum of male carinate with the segment depressed on each side . . . . *gracilis*
No terminal spines on apex of connexiva of female; metasternum of male not as above . . . . *ainsliei*

Rhagovelia ainsliei Drake and Harris

(Pl. VII, fig. 1)

1933. *Rhagovelia ainsliei* Drake and Harris, Proc. Biol. Soc. Washington, vol. 46, p. 50.

Size:

Length	*Width*
4.00 mm. apterous male	1.20 mm. apterous male
3.65 mm. apterous female	1.32 mm. apterous female
4.20 mm. winged male	1.52 mm. winged male
4.15 mm. winged female	1.50 mm. winged female

Color: General color black; clothed with brown pubescence. Pronotum with interrupted yellow band on anterior margin becoming pruinose behind eyes. Margins of connexiva yellow. Venter blue-gray. Venter of last abdominal segment brown beneath. Base of antennae, margins of all acetabulae, anterior and posterior coxae, all trochanters (intermediate trochanter varies from yellow to brown), and base of anterior femur yellow. Wings brown with black veins.

Structural characteristics: Terminal genital segment mucronate at apex. *Apterous male:* anterior trochanter armed with prominent brown spine. Anterior tibia straight, not dilate, and flattened on inner surface for apical one half. Pronotum with length subequal to width (L. 74, W. 73), broadly rounded behind, coarsely punctate, and with fairly distinct median, longitudinal carina; metanotum short on midline (L. 70, W. 80). Proportions of antennae: Seg. I: II: III: IV:: 67: 44: 30: 30; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 146: 95: 56: 56; of posterior legs: 110: 112: 14: 26. Abdomen tapers evenly to apex. Venter with median carina well defined on basal two abdominal segments; last ventral abdominal segment strongly impressed on each side of median, somewhat triangular portion. First genital segment conspicuously clothed with long, pale hairs beneath; apex of last genital segment mucronate. Minute, black, conical setae on base of jugum of head, on proepisternum, and on venter of abdomen. Posterior trochanter armed with four or five small, black teeth. Posterior femur moderately to strongly incrassate (L. 110, W. 32). Armed on basal two fifths with row of closely-set, short spines, and at basal two fifths with one long spine followed by approximately seven shorter, subequal spines, gradually decreasing to apex; also armed on apical one half with an anterior row of small, subequal spines. Posterior tibia straight, or on specimens with greatly incrassate hind femur can be curved outward on apical one third; armed within with one row of stout teeth with those at apical one third often larger than others; armed at apex with stout spur. *Apterous female:* anterior trochanter unarmed. Anterior tibia as in male. Pronotum formed as in male (L. 78, W. 77); metanotum short on midline (L. 7, W. 82). Proportions of antennae: 60: 35: 30: 28; of intermediate legs: 132: 87: 50: 58; of posterior legs: 107: 117: 15: 27. Connexivum strongly reflexed against sides of abdomen; margins not contiguous. Abdomen bent upwards at angle of forty-five degrees for last three segments. Venter without median carina. Apex of last genital segment mucronate. Minute, black, conical setae as in male. Intermediate femur dorso-ventrally flattened and excavate beneath from basal one fourth to apical one fourth. Posterior trochanter unarmed. Posterior femur not incrassate (L. 107, W. 15). Armed at apical two fifths with one long spine followed by four or five much smaller, gradually decreasing spines to apex. Posterior tibia straight, seemingly unarmed except for slender spur at apex. *Winged forms:* proportions and armature similar to apterous forms. Apex of genital segments mucronate. Pronotum of male triangular behind; apex raised and slightly produced into a short process (L. 7). Pronotum of female produced into long (L. 55), bulbous process curved downward near apex, with its apical portion densely clothed with long, brown hairs.

Comparative notes: This species resembles *R. gracilis* sp. nov. *R. ainsliei* Drake and Harris can be separated from *R. gracilis* sp. nov. by the lack of a spinelike process on the apex of the connexiva of the female, and by the lack of a median carina with the segment depressed on each side on the metasternum of the male.

Data on types: Holotype, apterous male; allotype, apterous female; morphotype, winged male; paratypes, several winged and apterous males and females. These specimens were collected in Guatemala City, Guatemala by C. N. Ainslie. The holotype, allotype and morphotype, as well as paratypes, are in the personal collection of Dr. C. J. Drake. A pair of apterous paratypes are in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on distribution: Recorded only from Guatemala. In addition to the paratype material specimens have been examined from the following localities (new records for major political areas are indicated with an asterisk):

GUATEMALA: Guatemala City, Ainslie, 1 apterous female (this specimen bears a paratype label of *R. hambletoni* Drake and Harris); Gualan, Jan. 23, '05 (J. R. de la Torre-Bueno Collection), 21 apterous males, 2 winged males, 21 apterous females, 5 winged females.

* HONDURAS: Negrito, Mar. 27, 1923, 1412, T. H. Hubbell, 1 apterous male, 1 winged male.

Rhagovelia becki Drake and Harris

(Pl. VII, fig. 2)

1936. *Rhagovelia becki* Drake and Harris, Proc. Biol. Soc. Washington, vol. 49, p. 106.

Size:	*Length*	*Width*
	5.44 mm. apterous male	1.29 mm. apterous male
	5.23 mm. apterous female	1.24 mm. apterous female

Color: General color black; clothed with light brown pubescence. Pronotum with anterior band interrupted at middle; orange behind vertex of head becoming pruinose behind eyes. Pronotum with darker, median, longitudinal line becoming evanescent on posterior one fifth. Margins of connexiva orange. Venter blue-gray. Venter of last abdominal segment black beneath. Base of antennae, margins of all acetabulae, anterior and posterior coxae, anterior and posterior trochanters, basal one half of intermediate trochanter, and basal one third of anterior femur orange to yellow.

Structural characteristics: Terminal genital segment mucronate at apex. *Apterous male:* anterior trochanter armed with prominent brown spine. Anterior tibia straight, flattened on inner surface, and not dilate. Pronotum coarsely punctate, each puncture surrounded by a shallow, pruinose depression; with faint, median carina; rather sharply rounded behind; longer than wide (L. 93, W. 80). Metanotum short on midline (L. 6, W. 82). Proportions of antennae: Seg. I: II: III: IV:: 85: 52: 35: 32; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 190: 130: 68: 66; of posterior legs: 150: 136: 19: 31. Abdomen elongate, tapers evenly to apex. Terminal genital segment mucronate. Venter with well defined median carina with segments depressed on each side on basal two abdominal segments. Minute, black, conical setae thinly scattered on base of jugum of head, proepisternum and mesosternum. Venter of last abdominal segment broadly flattened behind, with ridge along each side of flattened portion. First genital segment clothed with long yellow hairs. Posterior trochanter armed with four to six brown teeth. Posterior femur moderately incrassate (L. 150, W. 35). Armed with one long spine before middle followed by ten or eleven much shorter, subequal spines to apex; also armed on basal one half with row of closely-spaced, small, subequal spines, and from middle to apex with anterior row of short subequal spines. Posterior tibia straight; armed within with stout teeth, with those at apical one third being larger; armed at apex with stout spur. *Apterous female:* Anterior trochanter unarmed. Pronotum as in male (L. 91, W. 80); metanotum as in male (L. 6, W. 78). Proportions of antennae: 77: 46: —: —; of intermediate legs: 165: 110: 61: 66; of posterior legs: 128: 137: 19: 30. Abdomen above narrow on last four segments, the posterior margin with two irregular tufts of easily-broken hairs. Connexiva vertical; last two segments clothed with brown hair meeting above abdomen; each connexivum ending in mucronate, semierect process thickly clothed with long, dark-brown hairs. Terminal genital segment mucronate. Venter without median carina. Minute, black, conical setae as in male. Intermediate femur flattened beneath, not excavate. Posterior trochanter unarmed. Posterior femur not incrassate (L. 128, W. 18); armed after middle with one long spine followed by three or four smaller, rapidly decreasing spines to apex. Posterior tibia straight; armed within with several inconspicuous, widely-spaced teeth; armed at apex with small spur. *Winged forms:* unknown.

Comparative notes: This species resembles *R. ainsliei* Drake and Harris. *R. becki* Drake and Harris can be separated from *R. ainsliei* Drake and Harris by the elongate body, the longer than wide pronotum, and the mucronate processes at the apex of the connexiva of the female. *R. becki* Drake and Harris is also close to *R. gracilis* n. sp. but can be separated from that form by the more elongate body, by the lack of a carina on the mesothorax of the male, and by the last three segments of the abdomen not being bent upward in the female.

Data on types: Holotype, apterous male; allotype, apterous female; paratypes, 27 apterous males and females. The holotype, allotype, and 3 male paratypes were collected in the state of Nuevo León, Mexico, June 17, 1934, by D. E. Beck. The remaining paratypes were collected at Reagan Wells, Texas, March 6, 1936, by M. J. James. All type specimens are in the personal collection of Dr. C. J. Drake.

Data on distribution: Recorded from Mexico and Texas. Specimens have been examined from the following localities (new distribution records for major political areas are indicated with an asterisk):

MEXICO: * *Tamaulipas:* 3½ mi. west Forlon, Aug. 8, 1934, Smith & Dunkle, 1 apterous male.

UNITED STATES: *Texas:* Cocan, 7-6-36, R. H. Beamer, 2 apterous males, 2 apterous females.

Rhagovelia gracilis sp. nov.

(Pl. VII, fig. 3)

Size:	*Length*	*Width*
	4.15 mm. apterous male	1.26 mm. apterous male
	4.33 mm. apterous female	1.36 mm. apterous female
	4.25 mm. winged male	1.46 mm. winged male
	4.70 mm. winged female	1.53 mm. winged female

Color: General color gray-black. Anterior band of pronotum interrupted at middle; orange behind vertex of head, becoming pruinose behind eyes. Pronotum with darker, median, longitudinal line. Margins of connexiva yellow to orange. Venter gray to blue-gray. Venter of last abdominal segment brown to black beneath. Base of antennae, margins of all acetabulae, anterior and posterior coxae, all trochanters, and base of anterior femora yellow to orange. Wings brown becoming lighter toward apex, veins black.

Structural characteristics: Terminal genital segment mucronate at apex. *Apterous male:* anterior trochanter armed with slender brown spine. Anterior tibia not dilate, slightly flattened within on apical one third. Pronotum coarsely punctate, sharply rounded behind, and longer than wide (L. 82, W. 73); metanotum short on midline (L. 5, W. 75). Proportions of antennae: Seg. I: II: III: IV:: 65: 42: 28: 30; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 148: 94: 55: 55; of posterior legs: 115: 109: 15: 26. Venter with mesonotum depressed triangularly in center; metanotum depressed on each side of median carina; abdomen with median carina on basal two segments with venter depressed on each side. Minute, black, conical setae on base of jugum of head and on proepisternum. Venter of last abdominal segment excavate beneath with hairy ridges on each side of excavate area. Terminal genital segment mucronate. Posterior trochanter armed with six to eight small teeth. Posterior femur moderately incrassate (L. 115, W. 30). Armed on basal one half with row of short, closely-set spines, followed just beyond middle with one long, curved spine, and six or seven smaller, subequal spines to apex; also armed with anterior row of small teeth on apical one half. Posterior tibia straight; armed with one row of teeth, with those of basal one half being much more closely set than those on apical half; teeth at apical one third slightly larger than rest. *Apterous female:* anterior trochanter unarmed. Anterior tibia not dilate, slightly flattened on apical one third. Pronotum coarsely punctate, rather broadly rounded, and slightly longer than wide (L. 87, W. 84); mesonotum short on midline (L. 6, W. 85). Proportions of antennae: 75: 47: 32: 29; of intermediate legs: 157: 100: 62: 63; of posterior legs: 125: 130: 19: 28. Abdomen narrow above for last four segments; bent upward at an angle of forty-five degrees for last three segments. Connexiva closely reflexed over abdomen, converging to third from last segment, then spreading to just before apex where they converge again. Connexiva terminate in mucronate processes with their apices almost touching and which are reflexed over dorsum of first genital segment and extend length of first genital segment. Stiff groups of agglutinated hairs may be present at posterior angles of first genital segments or may have been broken away. Last genital segment mucronate. Venter of abdomen without ventral carina. Minute, black, conical setae on base of jugum of head and on proepisternum. Intermediate femur dorso-ventrally flattened, slightly excavate beneath from basal one fourth to apical one fourth. Posterior trochanter unarmed. Posterior femur not incrassate (L. 125, W. 16); armed beyond middle with one long spine followed by five or six very short, blunt spines to apex. Posterior tibia straight and armed with several feeble teeth on basal one third; armed at apex with slender spur. *Winged forms:* proportions and armature similar to apterous forms. *Winged male:* pronotum longer than wide (L. 125, W. 95), and drawn out at apex into short process (L. 11). Wings just cover mucronate genital segment. Venter formed as in apterous male. *Winged female:* pronotum drawn out at apex into long, bent process (L. 50), which is subequal in diameter throughout, and thickly beset with short hairs. Connexiva not reflected over abdomen. Each connexivum terminating in mucronate process which projects from beneath wing. Terminal genital segment mucronate and projects from beneath wing.

Comparative notes: This species resembles *R. ainsliei* Drake and Harris. *R. gracilis* sp. nov. can be separated from *R. ainsliei* Drake and Harris by the carina of the metasternum of the male, and the mucronate apices of the connexiva of the female. *R. gracilis* sp. nov. is also closely related to *R. becki* Drake and Harris and can be distinguished from that species by the carinate metasternum of the male; by the abdomen of the female which is bent upward at an angle of forty-five degrees in *R. gracilis* sp. nov. while remaining horizontal in *R. becki* Drake and Harris. Also the general body shape of *R. gracilis* sp. nov. is not as elongate as that of *R. becki* Drake and Harris.

Data on types: Holotype, apterous male; allotype, apterous female; holomorphotype, winged male; allomorphotype, winged female; paratypes, 6 apterous females. The type series was collected in the state of Chiapas, Mexico, Gutierrez, Aug. 27, 1937, by H. D. Thomas. All type specimens are in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on distribution: In addition to the type material specimens have been examined from the following localities:

MEXICO: *Guerrero:* La Sabana, kil. 226 S. of Mex. City, 10-20-36, H. D. Thomas, 1 apterous male, 9 winged males, 21 winged females; Río Agua, kil. 437, S. Mex. City, 10-31-36, H. D. Thomas, 3 apterous males.

Sinaloa: Mazatlán, May 1934, H. Hinton, 2 apterous males.

SPINIGERA GROUP

Group characteristics: The *spinigera* group can be characterized as those *Rhagovelia* in which the intermediate femur of the female is transversely constricted at the middle. The dorsum of the abdomen of the apterous female is narrow after the first three segments;

the connexiva is reflexed for the last four segments. Winged forms are common, the wings just cover the apex of the genital segments.

The following species comprise this group:

1. *R. choreutes* Hussey
2. *R. formosa* sp. nov.
3. *R. ignota* Drake and Harris
4. *R. spinigera* Champion

KEY TO THE SPECIES OF THE SPINIGERA GROUP

1. Posterior portion of first genital segment of male very swollen beneath; venter of last abdominal segment of male deeply and roundly excavate behind .... *ignota*

   Posterior portion of first genital segment of male normal beneath; venter of last abdominal segment of male not formed as above, 2

2.(1) Intermediate femur of male armed with short black spines for basal 1/3 .... *spinigera*

   Intermediate femur of male unarmed 3

3.(2) Anterior trochanter of male armed with a prominent brown spine; basal one fourth of posterior femur of male without a row of small teeth; pronotum of apterous forms definitely wider than long .... *formosa*

   Anterior trochanter of male unarmed; basal one fourth of posterior femur of male with a row of small teeth; pronotum of apterous forms with width subequal to length .... *choreutes*

Rhagovelia choreutes Hussey

(Pl. VI, fig. 1)

1925. *Rhagovelia choreutes* Hussey, Jour. New York Ent. Soc., vol. 33, pp. 61-69.

1926. *Rhagovelia choreutes*, Blatchley, Het. of East. N. America, p. 997 (gives redescription).

1927. *Rhagovelia choreutes*, Drake and Harris, Proc. Biol. Soc. Washington, vol. 40, p. 134 (record additional specimens from Gainsville, Florida, and new record from Texas).

1931. *Rhagovelia choreutes*, Gould, Kansas Univ. Sci. Bull., vol. 20, p. 19 (records from Florida, Oklahoma, and New Mexico; gives redescription; describes winged forms).

Size:	*Length*	*Width*
	3.72 mm. apterous male	1.19 mm. apterous male
	4.00 mm. apterous female	1.33 mm. apterous female
	4.22 mm. winged male	1.70 mm. winged male
	4.58 mm. winged female	1.86 mm. winged female

Color: General color black, covered with golden pubescence. Pronotum with anterior band interrupted at middle, orange behind vertex of head, becoming pruinose behind eyes. Margins of connexiva orange. Venter blue-gray. Venter of last abdominal segment brown to black beneath. Base of antennae, margins of all acetabulae, all coxae and trochanters, and basal one half of anterior femora yellow. Posterior femora light brown on basal one sixth. Apical segments of legs brown. Wings brown, veins black.

Structural characteristics: Intermediate femur of female transversely constricted at middle. *Apterous male:* anterior trochanter unarmed; anterior tibia not dilate, flattened within, and slightly excavate on apical one third. Pronotum distinctly but sparsely punctate, rounded behind, and almost as long as wide (L. 72, W. 73); metanotum short on midline (L. 6, W. 75). Proportions of antennae: Seg. I: II: III: IV:: 62: 36: 35: 34; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 117: 92: 44: 60; of posterior legs: 94: 100: 11: 24. Abdomen tapers rather evenly to apex, angle of taper increases on last three segments. Venter without median carina. Venter of last two abdominal segments slightly flattened beneath, lateral margins of flattened area being slightly raised into hairy calli. Minute, black, conical setae on base of jugum of head and scattered thinly on proespisternum and venter. Posterior trochanter armed with several small dark teeth. Posterior femur moderately incrassate (L. 94, W. 24); armed just before middle with one long spine followed by approximately five smaller, gradually decreasing spines to apex; also armed with row of small, knoblike teeth on basal one third, and row of small, subequal teeth anterior to main row of spines. Posterior tibia straight; armed on inner surface with small, subequal teeth, with those of basal two thirds more closely-set and somewhat larger than those of apical one third; armed at apex with bent spur. *Apterous female:* Pronotum truncate at apex (L. 75, W. 80); metanotum as in male (L. 6, W. 83). Proportions of antennae: 63: 38: 35: 34; of intermediate legs: 133: 95: 45: 67; of posterior legs: 100: 105: 12: 27. Intermediate femur transversely contricted at middle. Connexiva far apart at base of abdomen, converging abruptly on fourth segment from apex and contiguous for last one to three segments; diverging slightly on posterior half of last segment. Minute, conical, black setae as in male. Posterior trochanter unarmed. Posterior femur slightly incrassate (L. 100, W. 22); increasing gradually in diameter to first spine; armed at middle with one long spine followed by six or seven shorter, gradually decreasing spines to apex. Posterior tibia straight, inconspicuously armed on inner surface for basal one third; armed at apex with bent spur. *Winged forms:* proportions and armature similar to apterous forms. Pronotum continued into almost horizontal process at apex; for male this process is short (L. 10), for female long (L. 43) and thickly set with long hairs. Apex of wings extend slightly over apex of genital segments.

Comparative notes: This species is clearly in the *spinigera* group, as the females possess the transversely constricted intermediate femur, although that fact has not been noted previously. It most closely resembles *R. formosa* sp. nov. *R. choreutes* Hussey can be separated from *R. formosa* sp. nov. by the unarmed anterior trochanter in the male, by the armed basal one third of the posterior femur of the male, and by the length of the pronotum, in the apterous forms, which in *R. choreutes* Hussey is approximately as long as wide. The posterior femur of the female is also formed differently in the two species, being less abruptly expanded before the middle in *R. choreutes.*

Data on types: Holotype, apterous male; allotype, apterous female; paratypes, 170 apterous males and females. These type specimens were collected at Gainsville, Florida, on October 13, 1923, and April 9, 1925, by T. H. Hubbell. The holotype, allotype, and numerous paratypes are in R. F. Hussey's collection. Paratypes are also in the collection of H. G. Barber, J. R. de la Torre-Bueno (now in Kansas University Collection), C. J. Drake, H. B. Hungerford (in Kansas University Collection), H. M. Parshley, the museums of the University of Michigan and the University of Florida, the United States National Museum, and the American Museum of Natural History. Morphotype specimens are hereby designated as a winged male as holomorphotype, and a winged female as allomorphotype. These specimens were collected in Eddy Co., New Mexico, 7-9-27, by P. A. Readio and are in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on distribution: Recorded from Florida, New Mexico, Oklahoma and Texas. In addition to the type specimens mentioned above as being in the collection of the University of Kansas, specimens from the following localities have been examined (new records on distribution for major political areas are indicated with an asterisk):

* MEXICO: * *Chiapas:* La Libertad, 500 m.a.s.l., 1-1-38, Octavio Utrilla, 20 apterous males, 8 apterous females, 30 nymphs.

* *Nuevo León:* Sabinas Hidalgo, Alt. 1000 ft., pool in river June 14, 1940, H. Heogstraal, 92 apterous males, 63 apterous females.

UNITED STATES: *Florida:* Branford, 7-31-30, Paul W. Oman, 115 apterous males, 124 apterous females; Branford, 7-16-34, P. McKinstry, 10 apterous males, 2 apterous females; Branford, 7-16-34, R. H. Beamer, 2 apterous males, 7 apterous females.

* *Mississippi:* Ireland, 7-7-34, R. H. Beamer, Jr., 3 winged males, 4 winged females.

New Mexico: Eddy Co., 7-9-27, P. A. Readio, 22 apterous males, 14 apterous females.

Oklahoma: Arbuckle Mts., Davis, July, 1925, R. H. Beamer, 22 apterous males, 29 apterous females.

Texas: Brazoria Co., 8-12-28, L. D. Beamer, 1 apterous male; Hidalgo Co., 7-30-28, R. H. Beamer, 1 apterous male; Kendall Co., 7-22-28, R. H. Beamer, 9 apterous males, 29 apterous females; Kendall Co., 7-22-28, A. M. James, 4 apterous males, 4 apterous females; Kerr Co., 7-20-28, R. H. Beamer, 7 apterous males, 40 apterous females; Menard Co., 7-19-28, R. H. Beamer, 9 apterous males, 12 apterous females; Pinto, 7-7-38; R. I. Sailer, 5 apterous males, 2 winged males, 6 apterous females; Pinto, 7-7-38, D. W. Craik, 7 apterous males, 9 apterous females; San Antonio, 6-25-38, D. W. Craik, 8 apterous males, 7 apterous females; Sequin, 6-26-38, R. I. Sailer, 4 apterous females; Starr Co., 7-30-28, R. H. Beamer, 11 apterous males, 4 apterous females.

Rhagovelia formosa sp. nov.

(Pl. VI, fig. 2)

Size:	*Length*	*Width*
	3.45 mm. apterous male	1.13 mm. apterous male
	3.63 mm. apterous female	1.33 mm. apterous female
	3.82 mm. winged male	1.46 mm. winged male
	3.92 mm. winged female	1.53 mm. winged female

Color: General color very dark brown, clothed with golden pubescence. Anterior band of pronotum silver-yellow, interrupted at middle; posterior margins of pronotum slightly tinged with blue-gray. Connexiva margined with light brown. Venter blue-gray; venter of last abdominal segment and genital segments yellow to light brown. Base of antennae, all coxae, all trochanter, and bases of anterior and posterior femora yellow to light brown. Dorsum with blue-gray pilosity at juncture with connexivum. Wings lighter brown than pronotum; veins black.

Structural characteristics: Intermediate femur of female transversely constricted at middle. *Apterous male:* anterior trochanter armed with conspicuous brown spine. Anterior tibiae slightly dilate, slightly flattened on apical half. Pronotum most thickly punctate along posterior margin and wider than long (L. 62, W. 72); metanotum much wider than long (L. 6, W. 70). Proportions of antennae: Seg. I: II: III: IV:: 55: 28: 28: 29; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 113: 75: 34: 53; of posterior legs: 100: 83: 10: 20. Connexiva taper evenly to apex. Venter without median carina, except occasionally on basal one or two segments. Minute, black, conical setae on base of jugum of head, dorsal one half of proepisternum, and at sides of posterior margin of venter of last abdominal segment. Venter of last three abdominal segments with median depression forming longitudinal trough; depression of last abdominal segment bordered at sides with rather strong, hairy calli. Occasional specimens may not show this longitudinal depression on venter to any great extent. Genital segments hairy beneath, but otherwise normally formed. Posterior trochanter armed only with two or three feeble brown teeth. Posterior femur greatly incrassate (L. 100, W. 36) and armed before middle with one long, brown-tipped spine followed by eight smaller, decreasing spines to apex; also armed with anterior row of eight small, subequal spines which begins at approximately middle and continues to apex. Posterior tibiae straight and armed with two rows of stout teeth, with two or three teeth at middle and apical tooth somewhat enlarged; also armed with stout spur at apex. *Apterous female:* pronotum broadly depressed at middle on posterior margin and coarsely punctate along posterior border (L. 65, W. 88); metanotum broadly truncate and wider than long (L. 7, W. 85). Proportions of antennae: 60: 30: 30: 30; of intermediate legs: 113: 73: 33: 56; of posterior legs: 95: 88: 10: 23. Abdomen without ventral carina. Minute, conical, black setae on jugum of head and proepisternum. Abdomen narrow beyond first three segments with connexiva reflexed and their margins close together over last three abdominal segments. Apices of connexiva diverging slightly over apical half of last abdominal segment. Occasional specimens show dorsum of last one or two abdominal segments swollen and projecting above connexiva. First genital segment sloping downward at angle of forty-five degrees. Intermediate femora transversely constricted at approximately middle. Posterior trochanter unarmed. Posterior femur with basal one third subcylindrical (W. 15) and unarmed, abruptly expanding after basal third (W. 24) and armed just before middle with one long spine followed by six or seven smaller, decreasing spines to apex. Also armed after middle with anterior row of approximately three, small, black, subequal teeth running to apex. Posterior tibia straight, armed on basal half with fairly strong teeth which are much reduced on apical half, armed at apex with rather small spur.

Winged forms: last segment of antennae of winged male slightly longer than in apterous male, otherwise proportions and armature as in apterous forms. Connexiva not reflexed. Venter of abdomen of male as in apterous male. Formations of intermediate and posterior femora as in apterous forms. Posterior tips of wings not, or just barely covering genital segments. Pronotum of male produced at apex, into short process, while that of female is produced into long, pointed process standing from dorsum at an angle of approximately forty-five degrees.

Comparative notes: This species is in the group with *R. spinigera* Champion because of the constricted intermediate leg of the female. It is most closely related to *R. ignota* Drake and Harris from which the males may be separated by the formation of the venter of the abdomen and the normal ventral surface of the first genital segment, which is greatly enlarged in *R. ignota* Drake and Harris. The females may be separated by the form and armature of the posterior femur. The male claspers are of the same general type as in *R. ignota* Drake and Harris, but are broader at the apex and smaller than those of *R. ignota* Drake and Harris.

Data on types: Holotype, apterous male, allotype, apterous female; holomorphotype, winged male; allomorphotype, winged female; paratypes, 8 apterous males, 3 apterous females; paramorphotypes, 23 winged males, 12 winged females. Described from a series labeled: "Acapulco, Guerrero, Kil. 442 S. of Mex. City, 11-1-36, H. D. Thomas." All type specimens are in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on distribution: In addition to the type series, specimens have been examined from the following localities:

GUATEMALA: Amatitlan, 8-11-'05 (J. R. de la Torre-Bueno Collection), 50 apterous males, 106 apterous females; Gualan, 23-1-'05 (J. R. de la Torre-Bueno Collection), 7 apterous males, 5 apterous females, 4 winged females.

HONDURAS: Copán, 2-7-37, Chester Roys, 1 apterous male, 1 apterous female, 1 winged female; Copán, 2-18-37, Chester Roys, 2 apterous males, 1 winged male, 1 apterous female, 2 winged females.

MEXICO: *Chiapas:* Hda. La Libertad, Sept. 1, 1937, H. D. Thomas, 1 apterous male.

Guerrero: Río Agua, Kil. 437 S. Mex. City, 10-30-36, H. D. Thomas, 7 apterous males, 6 apterous females, 7 winged males, 5 winged females; Garrapatas, Kil. 369 S. Mex. City, 10-30-36, 1 apterous male, 3 apterous females, 17 winged males, 22 winged females.

Michoacán: El Sabino, Uruapan, 7-24-36, H. D. Thomas, 21 apterous males, 31 apterous females, 5 winged males, 4 winged females.

Morelos: Acatlipa, el. 4000 ft., 1-1946, Coll. J. C. Shaw, 5 apterous males, 1 apterous female; Cuautla, 10-12-36, H. D. Thomas, 30 apterous males, 42 apterous females; Cuntlan del Río, IV-26-44, J. G. Shaw, 3 apterous males, 3 apterous females.

Puebla: Tehuacán, July 18-25, 1937, H. D. Thomas, 54 apterous males, 12 apterous females.

Tamaulipas: 5 mi. N. of Ciudad, Victoria, 11-5-36, H. D. Thomas, 11 apterous males, 4 winged males, 15 apterous females, 5 winged females.

Rhagovelia ignota Drake and Harris

(Pl. VI, fig. 3)

1933. *Rhagovelia ignota* Drake and Harris, Proc. Biol. Soc. Washington, vol. 46, p. 51.

Size:	*Length*	*Width*
	3.72 mm. apterous male	1.19 mm. apterous male
	4.05 mm. apterous female	1.42 mm. apterous female
	4.20 mm. winged male	1.52 mm. winged male
	4.38 mm. winged female	1.58 mm. winged female

Color: General color brown-black, clothed with golden pubescence. Anterior band of pronotum yellow, interrupted at middle, becoming pruinose behind eyes. Mesonotum with pruinose areas surrounding each puncture. Shining black spots on dorsum of last one to several abdominal segments. Margins of connexiva orange to yellow. Venter blue-gray. Venter of last abdominal segment yellow beneath. Base of antennae, margins of all acetabulae, all coxae, all trochanters, and bases of anterior and posterior femora yellow. Wings brown-black or pruinose brown on basal one half, brown on apical one half.

Structural characteristics: Intermediate femur of female transversely constricted at middle. *Apterous male:* anterior trochanter unarmed. Anterior tibia dilate (L. 70, W. 15) and flattened on inner surface. Pronotum rounded at apex (L. 70, W. 77); metanotum short on midline (L. 7, W. 78). Proportions of antennae: Seg. I: II: III: IV:: 57: 32: 30: 32; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 121: 83: 40: 54; of posterior legs: 104: 94: 13: 24. Abdomen tapers evenly to apex. Venter with slight median carina on first two segments of abdomen. Minute, conical, black setae on jugum of head, proepisternum, scattered irregularly on venter, and on posterior margin of last abdominal segment at sides. Venter depressed in middle on posterior three segments; last segment deeply and roundly excavate behind with prominent callus on each side, crest of each callus being somewhat in front of middle of segment. First genital segment with posterior portion beneath greatly swollen and hairy. Posterior trochanter armed with several knoblike teeth. Posterior femur greatly incrassate (L. 104, W. 36) and armed with long, black-tipped, yellow spine at basal one third followed by nine or ten smaller, gradually decreasing spines to apex. Posterior femur also armed with row of very small, knoblike, inconspicuous teeth on basal one third, and row of small subequal spines anterior to primary armature. Posterior tibia straight; armed with two rows of small teeth with those of basal one half stronger and more closely-set; armed also with spur at apex. *Apterous female:* pronotum formed as in apterous male (L. 70, W. 83), metanotum as in male (L. 5, W. 83). Proportions of antennae: 57: 29: 26: 28; of intermediate legs: 115: 78: 35: 55; of posterior legs: 95: 93: 10: 24. Intermediate femora transversely constricted at middle. Abdomen tapers at first, practically parallel for last two segments. Connexiva vertical, not contiguous. Venter without median carina. Minute, conical, black setae on base of jugum of head, proepisternum, and scattered irregularly on venter. Posterior trochanter unarmed. Posterior femur moderately incrassate (L. 95, W. 23); gradually increasing in diameter for basal one half, increasing abruptly in diameter at middle, then tapering to apex. Posterior femur armed at middle with one long, yellow spine followed by seven smaller, gradually decreasing spines to apex; also armed after middle with anterior row of five or six small, subequal teeth. Posterior tibia straight; armed on basal one half with closely-set teeth, apical one half armed with two or three scattered small teeth and inconspicuous spur at apex. *Winged forms:* Proportions and armature similar to apterous forms. Pronotum carinate on midline; prolonged into short spine at apex in male (L. 15), and a long, slender spine in female (L. 45). Genital segments of male formed as in apterous forms. Intermediate and posterior legs of female formed as in apterous female. Pronotum coarsely and thickly punctate posterior to anterior band. Wings barely cover apex of genital segments.

Comparative notes: This species resembles *R. spinigera* Champion. *R. ignota* Drake and Harris can be separated from *R. spini-*

gera Champion by the first genital segment of the male which is greatly swollen beneath in *R. ignota,* and the formation of the posterior femur of the female.

Data on types: The holotype is a winged male from Guatemala, and is in the personal collection of Dr. C. J. Drake. The allotype is a winged female, and paratypes are two males and four females taken with the allotype from Honduras. These specimens are in the U. S. National Museum.

Data on distribution: Recorded from Guatemala and Honduras. Specimens from the following localities have been examined (new records for major political areas are indicated with an asterisk):

GUATEMALA: Gualan, 23-I-'05 (J. R. de la Torre-Bueno Collection), 2 apterous males, 3 apterous females; Agua Caliente 9-II-'05 (J. R. de la Torre-Bueno Collection), 2 apterous males; Mazatenango, Feb. 3, 1905 (J. R. de la Torre-Bueno Collection), 2 apterous males, 1 apterous female.

HONDURAS: Tegucigalpa, VII-18-18, F. J. Dyer Coll. No. 43870 (U. S. N. M. Collection), 3 apterous males; Dept Morazán, Esc. agr. Pan., Zomorano, 2600 ft. (creek bank) Aug. 2, 1948, T. H. Hubbell 181, 3 apterous males, 3 winged males, 1 apterous female.

* MEXICO: * *Chiapas:* Tuxla Gutierrez, Aug. 27, 1937, H. D. Thomas, 17 winged males, 12 winged females; Guadalupe, 800 m.a.s.l., 1-15-38, Octavio Utrilla L., 1 apterous male, 6 winged males, 1 apterous female; Hda. La Libertad, Sept. 1, 1937, H. D. Thomas, 5 winged males, 1 winged female.

* *Chihuahua:* Carimechi, Río Mayo, 1-7-35, H. S. Gentry, 3 apterous males, 1 winged male, 7 apterous females, 1 winged female.

* *Guerrero:* Chilapa, Oct. 29, 1930, Prof. L. Schultze, 1 winged female; Iguala, 10-7-36, H. D. Thomas, 25 winged males, 3 apterous females, 23 winged females; La Sabana, 226 kil. S. of Mex. City, 10-20-36, H. D. Thomas, 34 winged males, 40 winged females; Garrapatas, 369 kil. S. of Mex. City, 10-31-36, H. D. Thomas, 1 winged male.

* *Jalisco:* Tecotlotlan, 9-17-38, H. D. Thomas, 1 winged male, 3 winged females.

* *México:* Zamora, Sept. 9, 1938, H. D. Thomas, 2 winged males, 5 apterous females, 3 winged females; El Sabino, Uruapan, 7-24-36, H. D. Thomas, 1 winged male.

* *Morelos:* Acatlipa, el. 4000 ft., 1-1946, J. G. Shaw, 1 apterous male, 4 apterous females; Acatlipa, May 5, 44, J. G. Shaw, 1 apterous

male, 1 winged female; Acatlipa, 88 km. on Hgw. Mex. City to Acapulco, May 6, 45, J. G. Shaw, 1 apterous male, 1 apterous female; Cuernavaca, 10-5-36, H. D. Thomas, 1 winged male; Cuautla, 10-12-36, H. D. Thomas, 1 winged male, 1 winged female; Cuntlan del Río, IV-26-44, J. G. Shaw, 1 apterous male, 1 winged male, 2 apterous females; Hda. Cocoyotia, IV-14-44, J. G. Shaw, 1 apterous male, 3 winged males, 1 apterous female, 5 winged females.

* *Nuevo León:* Galeana, VII-3-39, H. Hoogstraal, 1 winged male.

* *Sonora:* San Bernardo, Río Mayo, 10-14-34, H. S. Gentry, 1 winged male, 21 winged females; Arroyo de los Mescales, Río Mayo, 2-16-35, H. S. Gentry, 14 winged males, 25 winged females.

* *Tamaulipas:* Victoria, 5 mi. N. of Ciudad, 11-5-36, H. D. Thomas, 2 apterous males, 3 winged males, 3 winged females; Victoria, VIII-1-41, Henry Thomas, 2 apterous males, 1 winged male, 2 apterous females, 1 winged female.

Rhagovelia spinigera Champion

(Pl. VI, fig. 4)

1898. *Rhagovelia spinigera* Champion, Biol. Centr. Amer., Het., vol. 2, p. 137.
1901. *Rhagovelia spinigera,* Kirkaldy, Ento. vol. 34, p. 308 (mentions in key).
1931. *Rhagovelia spinigera,* Gould, Kansas Univ. Sci. Bull., vol. 20, p. 43 (redescribes, records from Guatemala and Costa Rica).
1931. *Rhagovelia spinigera,* Drake and Harris, Pan Pacific Ent., vol. 8, p. 35 (record from Mexico as well as Costa Rica and Guatemala).
1933. *Rhagovelia spinigera,* Gould, Ann. Ent. Soc. America, vol. 26, p. 469 (records from Mexico).
1935. *Rhagovelia spinigera,* Drake and Harris, Proc. Biol. Soc. Washington, vol. 48, p. 36 (describe apterous form).

Size:	*Length*	*Width*
	4.05 mm. apterous male	1.33 mm. apterous male
	4.45 mm. apterous female	1.56 mm. apterous female
	4.50 mm. winged male	1.56 mm. winged male
	5.05 mm. winged female	1.78 mm. winged female

Color: General color brown-black, clothed with brown pubescence. Pronotum with silver-gray to pruinose orange band on anterior margin interrupted at middle by median, dark brown, longitudinal line which is more or less distinct for length of pronotum. Punctures of pronotum surrounded by narrow gray margin. Margins of connexiva orange. Venter blue-gray. Venter of last abdominal segment and genital segments yellow to light brown. Base of antennae, margins of all acetabulae, all coxae and trochanters, and basal one half of anterior femora yellow. Wings brown, lighter at apex; veins black.

Structural characteristics: Intermediate femur of female transversely constricted at middle. *Apterous male:* anterior trochanter unarmed; anterior tibia only slightly dilate, flattened within for anterior one half. Pronotum coarsely and thickly punctate, rounded at apex (L. 72, W. 84); mesonotum hidden; metanotum short on midline (L. 7, W. 85). Proportions of antennae: Seg. I: II: III: IV:: 56: 33: 30: 32; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 123: 85: 38: 55; of posterior legs: 102: 95: 12: 26. Slight ventral carina between posterior coxae. Minute, black, conical setae on base of jugum of head, proepisternum, and scattered irregularly on venter. Venter of last two segments of abdomen flattened beneath with slight, hairy calli on each side of median area. Intermediate trochanter armed with from four to ten small teeth. Intermediate femur armed on ventral surface with single row of approximately twelve small teeth on basal one third. Posterior trochanter armed with approximately ten very small, faint teeth. Posterior femur moderately incrassate (L. 102, W. 28) and armed on basal one third with row of small teeth, armed just before middle with one long spine followed by nine or ten smaller, gradually decreasing spines to apex. Posterior tibia straight; armed within with row of black teeth, with those of basal half stronger than those on apical half; armed at apex with inconspicuous spur. *Apterous female:* anterior tibia formed as in male. Pronotum punctate as in male (L. 83, W. 100); mesonotum hidden, metanotum flattened in middle, turgid to each side (L. 6, W. 104). Proportions of antennae: 66: 36: 34: 33; of intermediate legs: 130: 95: 40: 60; of posterior legs: 105: 115: 15: 27. Intermediate femur unarmed; with transverse constriction at middle; venter without median carina. Minute, conical, black setae as in male. Posterior trochanter unarmed. Posterior femur not as incrassate as that of male; subcylindrical for basal two fifths (W. 15), expanded abruptly at basal two fifths (W. 24); armed just beyond middle with one long, bent spine followed by seven or eight shorter, decreasing spines to apex. Posterior tibia straight; armed on basal one half with subequal, black teeth; seemingly unarmed at apex. *Winged forms:* proportions and armature similar to apterous forms. Pronotum of male produced into short process (L. 10); of female into long spiniform process projecting backwards at angle of forty-five degrees (L. 36). Trochanter and femur of intermediate leg of male armed as in apterous male. Femora of intermediate and posterior legs of female formed as in apterous female. Wings covering apex of genital segments.

Comparative notes: This species resembles *R. ignota* Drake and Harris. *R. spinigera* Champion can be separated from *R. ignota*

Drake and Harris by the armed intermediate trochanter and femur of the male, and by the formation of the posterior femur of the female, which is abruptly expanded before the insertion of the long spine, rather than being expanded at the point of insertion of the long spine as is the posterior femur of the female of *R. ignota* Drake and Harris. The males also lack the swollen genital segment which characterizes *R. ignota* Drake and Harris. Champion described this species from only the winged female or he would doubtlessly have noticed the armed intermediate femur of the male. *R. spinigera* Champion is the only species of *Rhagovelia* known to have such an armature.

Data on types: Champion's type material is in the British Museum. He gives the type locality as: "Guatemala, San Gerónimo in Vera Paz." Specimens in the Francis Huntington Snow Entomological Collections have been compared with the type material by Dr. H. B. Hungerford in 1928 and determined by him to be conspecific.

Data on distribution: Recorded from Guatemala, Costa Rica, and Mexico. Specimens from the following localities have been examined (new records for distribution in major political areas are indicated with an asterisk):

COSTA RICA: San José, Alt. 1160 m.a.s.l., Acequias, agua corriente, VIII, 1905, P. Biolley (J. R. de la Torre-Bueno Collection), 22 winged males, 2 apterous females, 12 winged females; R. Maria Aguilar, alt. 1160 m.a.s.l., Jan. 1905, P. Biolley (J. R. de la Torre-Bueno Collection), 5 apterous males, 8 winged males, 8 apterous females, 9 winged females; San José, Purchased 6-31, H. Schmidt, 10 apterous males, 6 apterous females, 3 winged females; San José, Heinrich Schmidt, purchased 1932, 2 apterous males, 1 winged male, 3 apterous females, 4 winged females; San José, 6 & 7, 1931, Heinrich Schmidt, bought from Schmidt, 11 apterous males, 40 winged males, 13 apterous females, 25 winged females; Río Torres, 2-10-32, Heinrich Schmidt, bought from collector, 3 apterous males, 2 winged males, 4 apterous females, 9 winged females; Río Tiribi, 1100 m.a.s.l., IV-06, P. Biolley (J. R. de la Torre-Bueno Collection), 1 winged male, 3 winged females; Río Virilla, 12-26-31, Heinrich Schmidt, purchased from collector, 38 apterous males, 63 winged males, 25 apterous females.

GUATEMALA: Mazatenango, 3 Feb., 05 (J. R. de la Torre-Bueno Collection), 6 apterous males, 3 apterous females; Agua Caliente, 28-I-05 (J. R. de la Torre-Bueno Collection), 6 apterous males, 5 winged males, 6 apterous females, 3 winged females; Agua Caliente, 9-II-05 (J. R. de la Torre-Bueno Collection), 13 apterous males, 1 winged male, 3 apterous females, 3 winged females.

* HONDURAS: Copán, 2-7-37, Chester Roys, 2 winged males, 1 winged female; Tegucigalpa, VIII-18-18, F. J. Dyer Coll. No. 34870 (U. S. National Museum Collection), 1 apterous male; Dept. Morazán, Esc. Agr. Pan., Zomorano, 2600, creek bank, Aug. 2, 1948; T. H. Hubbell, 181, 3 apterous males, 2 apterous females.

MEXICO: *Chiapas:* Hda La Libertad, Sept. 1, 1937, H. D. Thomas, 15 winged males, 4 winged females; Guadalupe, 1-15-38, 800 m.a.s.l., Octavio Utrilla L., 7 apterous males, 17 winged males, 14 apterous females, 11 winged females, 10 nymphs; Tuxtla Gutierrez, Aug. 27, 1937; H. D. Thomas, 6 winged males, 6 winged females.

Guerrero: Garrapatas, kil. 360 S. of Mex. City, 10-20-36, H. D. Thomas, 7 apterous males, 20 winged males, 18 apterous females, 11 winged females; La Sabana, kil. 226 S. of Mex. City, 10-20-36, H. D. Thomas, 6 winged males, 8 winged females.

Jalisco: Tecolotlan, 9-17-38, H. D. Thomas, 2 winged males.

México: Tejupilco, Dist. of Temascaltepec, alt. 1340 m.a.s.l., June-July, 1933, H. E. Hinton, 21 winged males, 1 apterous female, 8 winged females.

Michoacán: Zamora, Sept. 9, 1938, H. D. Thomas, 1 winged male, 1 winged female; El Sabino, Uruapan, 7-24-36, H. D. Thomas, 5 apterous males, 5 winged males, 3 apterous females, 2 winged females.

Morelos: Hda Cocoyotla, IV-14-44, J. G. Shaw, 2 apterous males, 2 winged males, 2 apterous females.

UNKNOWN SPECIES

The following two species have not been included in any group or key as the descriptions are not sufficiently detailed nor specimens available.

Rhagovelia bakeri Bergroth

1914. *Rhagovelia bakeri* Bergroth, Psyche, vol. 21, p. 74.
1931. *Rhagovelia bakeri*, Gould, Kansas Univ. Sci. Bull., vol. 20, p. 17 (redescribes).

This species is not represented in the material in the Francis Huntington Snow Entomological Collections, University of Kansas. The original description is quoted below:

"Above black, beneath grayish black, legs greenish black, somewhat aenescent, pronotum with an apical whitish fascia interrupted in the middle, abdomen at the sides immediately within the margin narrowly and obscurely streaked with yellowish brown, basal part of the first antennal joint, anterior acetabula, all coxae and trochanters, and basal part of fore femora yellow, hind femora at the base above and beneath also tinged with yellow. Head with an impressed median line in front, rostrum passing the middle of the mesosternum, antennae with the first two joints pubescent, with scattered longer hairs, outer margin of the last three joints straight, inner margin slightly convex, first joint one half longer than second, third a little shorter than second, fourth hardly shorter than third, pointed at tip. Mesosternum with the ridges between the anterior and the middle coxae well marked, pubescent, curved inwardly, strongly divergent posteriorly. Abdomen gradually tapering to the tip, not carinated beneath. Legs pubescent, with scattered longer hairs, middle femora thickened toward the base, middle tarsi a little longer than the tibiae, the second joint a little shorter than the third, posterior tibiae with a short straight spur at apex.

"*Apterous male:* Pronotum a little broader than long, rounded behind. Last dorsal segment of abdomen truncate at apex, last ventral segment arcuately emarginate at apex. First genital segment ferruginous beneath at the base. Posterior, femora very strongly incrassate, not reaching the tip of the apical genital segment, spined beneath from the apex to a little beyond the middle, the first spine (near the middle) the longest, the following gradually diminishing in length toward the apex. Posterior tibia straight, finely denticulate beneath down their whole length, without large teeth, the teeth of the middle third slightly longer, the apical third slightly narrower than the rest. Length, 4 mm.

"Locality: Nicaragua (Granada).

"Allied to *Rh. femoralis* Champ., but the antennae are differently constructed; the venter is not ridged in the middle; the posterior tibiae have no large teeth, etc."

Comparative notes: From the description quoted above it would appear that *R. bakeri* Bergroth belongs in the *crassipes* group. Specimens will have to be examined before a more complete relationship can be established. The incomplete description will not allow this species to be placed in a key. Bergroth's type material is apparently lost, making it impossible to determine the relationships of this species.

Rhagovelia trailii (White)

1879. *Neovelia trailii* White, Jour. Linn. Soc. London, Zool., vol. 14, p. 487.
1901. *Rhagovelia trailii,* Kirkaldy, Ent., vol. 34, p. 308 (places in genus *Rhagovelia*).
1931. *Rhagovelia trailii,* Gould, Kansas Univ. Sci. Bull., vol. 20, p. 45.

This species was originaly described from two specimens, both winged females. The description is mostly based on color. The relationships of this species cannot be determined with sufficient accuracy to permit its being placed in any of the groups of species or included in the keys. The original description is quoted below.

"Nigro-Brunea, pubescentia confera concolori vestita, capite, antennis, pedibus, pronoto postico abdominisque lateribus parce nigrosetulosis; pronoto antice, prostethio, connexivo, ventre ad medium, antennarum atriculo primo ad basin, coxis, trochanteribus, femorum anticorum macula et vitta subtus, femorum posticorum basi et spinis ad basin flavido-fulvis; pronoti carina centrali sub-elevata plus minus, praecique antrosum, rufo-fulva. Male long. 4, lat. 1½ millim.

"Hab. Brasiliam borealem. (Manáos, August, 1874, 'at light,' J. W. H. Trail.)"

The type and the one cotype are both winged females and are in the British Museum.

Data on distribution: Known only from the type series.

ADDENDA

The following pages contain description of seven new species of *Rhagovelia.* These were described by Dr. C. J. Drake after the main body of this paper was completed. Specimens of *R. citata* Drake and *R. itatiaiana* Drake were available to the author and redescribed by him; other descriptions are the original descriptions by Dr. Drake. Dr. Drake's comparative measurements are to the same scale, at the same magnification, and such that 80 units equal one millimeter. The types are in the collection of Dr. Drake.

Due to the fact that specimens of most of these species were unavailable to the author no attempt has been made to include these species in either groups or keys. The species included in the addenda are:

1. *R. acapulcana* Drake
2. *R. citata* Drake
3. *R. itatiaiana* Drake
4. *R. novana* Drake
5. *R. rioana* Drake
6. *R. triangula* Drake
7. *R. torreyana* Drake and Hussey
8. *R. zeteki* Drake

Rhagovelia acapulcana Drake

1953. *Rhagovelia acapulcana* Drake, Proc. Biol. Soc. Washington, vol. 66, p. 145.

"*Apterous female:* Large, fusiform, black with a short interrupted band near the front margin of pronotum orange-brown; connexiva broadly margined with yellowish brown, the large terminal spines black; basal part of antennae, most of all acetabulae, middle and hind coxae, all trochanters and basal part of fore femora pale testaceous. Body beneath, head in front and fore part of pronotum bluish. Length, 4.10 mm.; width, 1.36 mm.

"Head with usual impressed lines and marks. Antennae with a few scattered stiff hairs on first two segments, measurements—segment I, 76; II, 45; III, 30; IV, 35. Pronotum large, covering most of mesonotum, punctate, broadly rounded behind, with median carina, beset with long erect dark hairs along entire hind margin, the width and length subequal (100; 98). Abdomen sharply narrowed on basal part, then slowly tapering for the last three segments; connexiva moderately wide, strongly reflexed with the outer margins not touching and projecting above the tergites, each connexivum termining behind in a very long, stout, black, hairy spine, which is directed obliquely inwardly so that the tips of the two spines contact each other. Apex of genital segment broad, sharply truncate. Anterior trochanters unarmed; tibiae slightly dilate and slightly excavate on apical half. Measurement of middle femora, 164; tibiae, 100; tarsi II, 16 and III, 28. Male and winged form unknown.

"*Holotype* (female), Acapulco, Mex., July 23, 1950 and 1 paratype, same locality, Aug. 3, 1951, both by C. J. Drake.

"The extremely large black spine at the posterior end of each connexivum separates this insect at once from other American species of the genus."

Rhagovelia citata Drake

(Pl. VIII, fig. 1)

1953. *Rhagovelia citata* Drake, Proc. Biol. Soc. Washington, vol. 66, p. 146.

Size:	*Length*	*Width*
	5.30 mm. apterous male	1.50 mm. apterous male
	5.80 mm. apterous female	1.70 mm. apterous female
	5.50 mm. winged female	2.00 mm. winged female

Color: General color red-brown, clothed with a golden pubescence. Anterior one sixth of pronotum with band of yellow brown; pronotum also with median longitudinal line and thin posterior margin slightly lighter. Disc of pronotum lighter in color than dorsum of abdomen. Connexiva broadly margined with yellow-brown. Venter lighter in color than dorsum. All legs yellow-brown. Wings brown, veins prominent and black.

Structural characteristics: Dorsum of abdomen of apterous female narrowed after first three segments, connexiva vertical; anterior tibia moderately dilate and excavate within in male. *Apterous male:* anterior trochanter unarmed; anterior tibia moderately dilate (W. 17) and slightly excavate for apical half. Pronotum wider than long (L. 76, W. 88); metanotum much wider than long (L. 2, W. 90). Proportions of antennae: Seg. I: II: III: IV:: 80: 48: 46: 43; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 170: 129: 61: 70; of posterior legs: 136: 138: 18: 33. Abdomen tapers evenly to apex. Ventral carina most strongly produced between posterior coxae where venter is depressed on each side; carina only slightly produced between posterior trochanters. Minute black conical setae sparsely scattered on base of jugum of head and one or two along posterior margin of last abdominal segment at sides. Venter of last abdominal segment depressed for posterior two thirds, bordered with a slight callus, raised longitudinal carina faintly indicated on posterior one half. Posterior trochanter armed with many small, light colored teeth. Posterior femur moderately incrassate (L. 136, W. 34) and armed with a row of closely set teeth on basal two fifths, armed at basal two fifths with a long, black-tipped spine followed by a row of twelve to thirteen decreasing spines to apex; also with an anterior row of subequal teeth from the middle continuing to the apex. Posterior tibia straight; armed beneath with a row of closely set teeth and a partial second row with a few scattered teeth; posterior tibia also armed with a stout slightly bent spur at apex. *Apterous female:* anterior tibia flattened within for apical half, slightly dilate. Pronotum wider than long (L. 98, W. 114); metanotum as in male (L. 5, W. 110). Proportions of antennae: 94: 53: 49: 45; of intermediate legs: 179: 136: 67: 74; of posterior legs: 142: 154: 20: 32. Connexiva meeting after first three segments, spreading slightly for last segment and terminating in a thick clump of long dark hairs. Dorsum of abdomen narrow after first three segments. No ventral carina. Minute, black, conical setae as in male. Posterior trochanter unarmed. Posterior femur only slightly swollen (L. 142, W. 23); armed at apical third with one medium sized spine followed by a rapidly decreasing series of four or five smaller spines to apex. Posterior tibia unarmed except for spur at apex.

Winged female: proportions armature, and arrangement of black, minute, conical setae much as in apterous female. Pronotum produced into a long, bent process (L. 62) which tapers to point at its apex. *Winged male:* unknown.

Comparative notes: This species is in the *collaris* group and appears to be a close relative of *R. armata* (Burmeister) but can be separated at once from that form by the pattern of the minute, black, conical, setae which are only thinly scattered on the base of jugum of head and occasionally along the posterior margin of the last abdominal segment at the sides.

Data on types: Holotype, apterous male; allotype, apterous female; allomorphotype, winged female. Described from a series labeled: "Canal Zone, Panama, Feb. 12, 1939, C. J. Drake." Paratypes, 48 specimens taken with types and several collections from Venezuela. The type material is in the personal collection of Dr. C. J. Drake. Three apterous males, 1 apterous female, and one winged female paratypes are in the Francis Huntington Snow Entomological Collections of the University of Kansas.

Data on distribution: Known only from the type series Panama and Venezuela.

Rhagovelia itatiaiana Drake

1953. *Rhagovelia itatiaiana* Drake, Proc. Biol. Soc. Washington, vol. 66, p. 147.

Size:	*Length*	*Width*
	3.15 mm. apterous male	1.14 mm. apterous male
	3.40 mm. apterous female	1.19 mm. apterous female

Color: General color brown-black with prominent yellow markings, clothed with a golden pubescence. Head with yellow stripe in front, extending onto vertex in some specimens. Pronotum with anterior one third yellow; mesonotum yellow except for faintly darker margins. Metanotum with yellow areas at humeral angles on some specimens. Connexiva, on both sides, broadly yellow except for thin brown outer margin. Yellow beneath except for venter of abdomen which is blue-gray; last two or three segments of venter of abdomen with yellow spots at sides. All coxae, all trochanters, basal one half of anterior femora and basal one half of posterior femora of female and whole of posterior femora of male beneath yellow.

Structural characteristics: Pronotum in apterous forms abbreviated, rounded behind, and exposing much of mesonotum. *Apterous male:* anterior trochanter unarmed. Anterior tibia not dilate, flattened within. Pronotum short (L. 31, W. 61); mesonotum truncate at apex (L. 20, W. 65); metanotum short (L. 3, W. 70). Antennal segments and intermediate legs broken off on specimens at hand.* Proportions of posterior legs: Fem.: Tib.: Tars. II: Tars. III:: 92: 68: 4: 22. Abdomen tapers rather evenly to apex, angle of taper increasing slightly for last three segments. Venter with slight median carina, becoming more pronounced on the anterior one half of the last abdominal segment. Posterior trochanter unarmed. Posterior femur strongly incrassate (L. 92, W. 29). Armed on basal one third with a single row of small dark teeth; armed after basal one third with a closely set row of thirteen to fifteen gradually decreasing spines to apex. Also armed with a few short, dark teeth in an anterior row on apical one fifth of the femur. Posterior tibia slightly arcuate; armed within with a row of closely set teeth; armed with a stout spur at apex. *Apterous female:* pronotum rounded behind (L. 28, W. 62); mesonotum truncate at apex (L. 22, W. 68); metanotum short on midline (L. 5, W. 77). Antennae broken.† Proportions of intermediate legs: 100: 79: 32: 45; of posterior legs: 79: 79: 19: 7. Abdomen tapers evenly to apex. Venter without median carina. Posterior trochanter unarmed. Posterior femur moderately incrassate (L. 79, W. 18) and armed after the middle with a dark spine followed by seven or eight regularly spaced, decreasing spines to apex. Posterior tibia straight, unarmed. *Winged forms:* unknown.

Comparative notes: This species is in the *abrupta* group and is very similar in appearance to *R. mira* Drake and Harris. *R. itatiaiana* Drake is much smaller than that form and the strongly produced ventral carina on the anterior half of the last abdominal segment of the male will set it apart at once.

Data on types: Holotype, apterous male, allotype, apterous female and 22 apterous paratypes in the personal collection of Dr. C. J. Drake. One male and one female paratype are in the Francis Huntington Snow Entomological Collections of the University of Kansas. The type series is labeled "Fas Pendo, Italiaia, Guapimir M. and Gavea, Rio Janeiro, Brazil."

Data on distribution: Known only from the type series.

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* Dr. Drake gives these measurements in his original description as follows: for antennae: "I, 65; II, 40; III, 45; IV, 38"; for intermediate leg: "femora, 120; tibiae, 95; tarsi II, 45 and III, 56." Dr. Drake used a comparative scale in which 80 units equalled 1 mm. for these measurements.

† Dr. Drake gives these measurements in his original description as follows: "I, 60; II, 35; III, 40; IV, 35."

Rhagovelia novana Drake

1953. *Rhagovelia novana* Drake, Proc. Biol. Soc. Washington, vol. 66, p. 150.

"Small, blackish with a short, median, interrupted, yellowish stripe on pronotum; pubescence dark brown; body beneath dark bluish, the pronotum also a little bluish. Antennae brownish black with basal part of first segment testaceous. Legs brownish black, the anterior coxae testaceous. Length (male) 2.30 mm., (female) 2.50 mm.; width (male), 1.10 mm.; (female), 1.25 mm. Winged form unknown.

"*Male:* Head with usual impressed lines and scattered long hairs. Antennae shortly pilose, with the usual bristly hairs on first two segments: measurements—I, 65; II, 45; III, 38; IV, 35 (same in both sexes). Pronotum very short, not produced posteriorly over mesonotum, much wider than long (68: 18). Mesonotum large, convex above, covering most of metanotum, wider than long (82: 62). Abdomen strongly tapering posteriorly; connexiva wide, gradually tapering to the end of the last tergite, reflexed obliquely upward. Legs long, slender, all femora unarmed in both sexes; anterior trochanters unarmed; hind tibiae without distinct spur at apex. Anterior tibiae slightly dilate apically; measurements of middle legs—femora, 150; tibiae, 100; tarsal segment II, 32 and III, 28. Hind legs—femora 110; tibiae, 116; tarsal segment II, 4 and III, 10. First genital setment (*sic*) rounded above, feebly roundly excavated behind.

"*Female:* Broader than male; pronotum very short, not produced behind over mesonotum. Antennal measurements as in male. Mesonotum large, wider than long (92: 80). Abdomen strongly narrowed posteriorly, unusually strongly constricted at the base of last segment, there narrow and nearly flat laterally, then abruptly widened behind, the apical part enlarged and about three times as wide as at constriction; connexiva strongly reflexed, not quite resting on tergites on basal half, from the constricted part posteriorly resting on tergites with their outer margins in contact with each other; abdominal tergite at base of constriction with a median semiovate plate raised vertically and projecting obliquely posteriorly between the outer edges of the reflexed connexiva, the outer edge of the plate clothed with rather long hairs; genital segments also with long brownish hairs. Legs unarmed, about the same thickness as in male. Measurements—middle femora, 142; tibiae, 108; tarsi II, 64 and III, 56. Hind femora, 100; tibiae, 144; tarsi II, 11 and III, 23.

"The extremely constricted abdomen a little before apex with enlarged short apical part and the singular vertical plate-like structure before apex of abdomen separate this peculiar insect at once from its congeners. The hind femora of the male is unarmed as in *R. longipes* Gould, but the entire insect is much smaller."

Rhagovelia rioana Drake

1953. *Rhagovelia rioana* Drake, Proc. Biol. Soc. Washington, vol. 66, p. 152.

"*Apterous form:* Small, black with the short pronotal band interrupted at the middle; pubescence brownish; entire body beneath bluish gray, sometimes also the fore part of pronotum. Antennae black with proximal part of first segment pale testaceous. Legs entirely black, sometimes the fore coxae partly flavous. Length (male), 2.75 mm. and (female), 3.00 mm.; width (male), 1.30 mm. and (female), 1.42 mm.

"*Male:* Head with the usual impressed median line and scattered long hairs. Antennae shortly pilose, with a few scattered bristly hairs on first two segments; measurements—I, 92; II, 48; III, 45; IV, 50. Pronotum very short, not produced over mesonotum, much wider than long (85: 25). Mesonotum large, covering most of metanotum, roundly narrowed on the sides posteriorly, blunt and rounded at the apex, wider than long (100: 70). Metanotum largely concealed; with hind margin and sides visible. Abdomen strongly tapering posteriorly; connexiva slightly reflexed, with outer margin feebly rounded. First genital segment beneath almost cylindrical. Legs long and slender. Anterior trochanters unarmed; tibia not dilate. Length of middle femora, 180; tibiae, 120; tarsi II, 68; III, 64. Hind femora not incrassate, unarmed, the tibiae also unarmed and without apical spur: measurements—femora, 120; tibiae, 130; tarsi II, 10 and III, 35.

"*Female:* Broader than male, with appendages about the same size. Pronotum short and sutured-off as in male. Mesonotum large, covering most of metanotum, broader than long (104: 76), with apex broad and subtruncate. Abdomen strongly tapering posteriorly, slightly constricted a little in front of genital segment; connexiva completely reflexed behind, with outer margins barely in contact on penultimate tergite with outer margins raised and flaring anteriorly, obliquely narrowed on last tergite leaving the median part of tergite uncovered, last tergite raised medially apically so as to form a narrow plate with the rounded apex projecting a little over narrow basal part of genital segment. Last ventrite nearly as long as the two preceding segments.

"*Alate* form: Pronotum moderately convex, with a fairly distinct median carina, nearly triangular behind with apex rounded, very little wider than long (124: 110). Hemelytra dark fuscous, wings fuscous, both longer than abdomen; tips of both wings broken-off in front of the genital segments in both male and female.

"Holotype (male) and allotype (female), both aperous (*sic*), Guapimir M., Rio de Janeiro, Braz. Paratypes, 14 specimens, same data as type.

"The small size, measurements of appendages, unarmed and not swollen hind femora and the connexiva and last tergite in female distinguish *R. rioana* from *R. longipes* and allied forms and allied forms with slender and unarmed legs."

Rhagovelia torreyana Drake and Hussey

(Pl. VIII, fig. 4)

1955. *Rhagovelia torreyana* Drake and Hussey.

Size:	*Length*	*Width*
	3.75 mm. apterous male	1.26 mm. apterous male
	3.80 mm. apterous female	1.28 mm. apterous female

Color: General color black, clothed with golden pubescence. Anterior one fifth of pronotum with orange band interrupted at middle. Dorsum of first two abdominal segments pruinose at sides in female. Margins of connexiva orange. Venter gray-black. Venter of last abdominal segment orange beneath. Base of antennae, all acetabulae, all coxae, all trochanters, and femora of all legs beneath yellow to orange.

Structural characteristics: Pronotum of apterous form covers mesonotum. Dorsum of abdomen of apterous female slightly constricted after first three segments. Posterior tibia without sickle-shaped spur at apex. *Apterous male:* anterior trochanter unarmed. Anterior tibia only slightly dilate and flattened within. Pronotum broadly rounded behind, slightly depressed along posterior margin (L. 62, W. 70) and covering mesonotum. Metanotum short on midline (L. 6, W. 73). Proportions of antennae: Seg. I: II: III: IV:: 59: 32: 40: 39; of intermediate legs: Fem.: Tib.: Tars. II: Tars. III:: 113: 100: 40: 53; of posterior legs: 104: 95: 9: 22. Abdomen tapers evenly to apex. Connexiva semi-vertical. Venter with no trace of median carina. No minute, conical, black setae on proepisternum. Posterior trochanter armed with from four to six short teeth in a single row. Posterior femur moderately incrassate (L. 104, W. 37); armed on basal one third with a median row of short, knoblike teeth, armed before the middle with a row of eight to ten equidistant, gradually decreasing spines to apex. Also armed with an anterior row of short subequal spines beginning at basal one third and continuing to apex. Posterior tibia almost straight and armed within with a single row of short, black teeth and a slender spur at apex. *Apterous female:* anterior tibia as in male. Pronotum formed as in male (L. 55, W. 77). Metanotum as in male (L. 6, W. 80). Proportions of antennae: 59: 28: 36: 36; of intermediate legs: 122: 93: 36: 55; of posterior legs: 92: 100: 9: 25. Dorsum of abdomen tapering inward for first four segments then subparallel to apex. Connexiva almost vertical. Posterior trochanter unarmed. Posterior femur only slightly incrassate (L. 92, W. 22); armed after the middle with one long black tipped spine followed by four to five much smaller, rapidly decreasing spines to apex. Posterior tibia straight and armed with a few, widely scattered black teeth or seemingly unarmed except for a slender spur at apex. *Winged forms:* unknown.

Comparative notes: This species is in the *crassipes* group and closely related to *R. amazonensis* Gould. *R. torreyana* Drake and Hussey can be separated from *R. amazonensis* Gould by the armature of the posterior femur in both males and females.

Data on types: The type series was collected in Liberty Co., Florida, Torreya St. Park, May 22, 1954, by R. F. Hussey. The holotype and allotype are in the personal collection of Dr. C. J. Drake, numerous paratypes are in the collection of R. F. Hussey. One male and one female paratype are also in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on distribution: Known only from the type locality.

Rhagovelia triangula Drake

1953. *Rhagovelia triangula* Drake, Proc. Biol. Soc. Washington, vol. 66, p. 148.

"*Apterous male:* Small, fusiform, with a short, transverse interrupted orange band near front pronotol margin; pubescence brownish. Base of first antennal segment, all coxae, all trochanters (save sometimes median), and basal third of anterior femora testaceous. Rustrum (*sic*) dark ferrugineous. Body beneath, front of head and fore part of pronotum bluish. Length, 2.85 mm.; width, 1.25 mm.

"Pronotum produced posteriorly, covering nearly one-half of mesonotum, broadly rounded behind, wider than long (78: 44). Mesonotum not as long as pronotum, wider than long. Antennal measurements—I, 58; II, 32; III, 40; IV, 40. Anterior trochanter unarmed; tibiae slightly dilate apically. Measurements of middle femora, 120; tibiae, 95; tarsi II, 52, and III, 56. Hind trochanters unarmed; femora moderately incrassate, armed near the basal third with a long dark spine, thence to apex with seven or eight smaller and rapidly decreasing spines; tibiae nearly straight; armed beneath with numerous, closely-set, short, stout teeth, and at the apex with a sharp spur; measurements—femora, 84; tibiae, 90; tarsi II, 12 and III, 25.

"*Winged female:* Head and antennae as in male. Pronotum moderately convex, extremely long, with hind part longly produced, nearly flat, coarsely punctate, rounded at apex, distinctly longer than wide (160; 120). Hemelytra dark brown, much longer than abdomen, the veins fairly distinct. Venter with the hairy median carina not present on last segment; last ventrite longer than the preceding two segments, strongly narrowed ventrally and laterally to hind margin. Measurements of middle femora, 100; tibiae, 92; tarsi II, 45, and III, 55. Hind femora a little incrassate, not as large as in male, armed at the apical third with a rather short spine, then followed with three or four shorter ones. Wingless female unknown. Length, 4.00 mm.; width, 1.25 mm.

"*Macropterous male:* Similar to female in general aspect. Pronotum much shorter and equal in width and length (110: 110), the posterior triangular part not unusually extended behind.

"*Holotype* (apterous male), and *allotype* (alate female), Guapimir M. Rio de Janeiro, Braz. *Paratypes,* 4 specimens, taken with the type.

"Separated from its congeners (pronotum concealing about one-half of mesonotum in apterous form) by the measurements of appendages, male parameres and the unusually longly produced hind part of the pronotum in the winged female. The pronotum in the alate female does not bear a horn or other modifications, just the regular hind triangular part longly extended."

Rhagovelia zeteki Drake

1953. *Rhagovelia zeteki* Drake, Proc. Biol. Soc. Washington, vol. 66, p. 145.

"*Apterous form:* Small, fusiform, dark brown with a solid orange-yellow band near anterior margin of pronotum, clothed with short golden pubescence and fine erect brownish hairs (hairs a little more numerous in male). Basal part of antennae, fore and hind coxae and the basal part of fore femora (nearly half beneath) pale testaceous. Legs and antennae black-fuscous. Length, 310 mm., width, 1.12 mm.

"*Male:* Antennae with the first three segments beset in front with numerous long brown hairs; measurements—I, 55; II, 35; III, 31; IV, 31. Legs with numerous long dark brown hairs; anterior trochanters unarmed, the tibiae a little dilate and flattened apically. Measurement of middle femora, 130; tibiae, 73; tarsi II, 40 and III, 58. Hind femora considerably swollen, armed near the basal third with a large bent black-tipped spine, thence to apex with a double row (8-10 spines in row) of smaller-decreasing spines; tibiae a little bent, with a spur at apex, armed beneath with a double row of numerous short blunt teeth; measurements—femora, 102; tibiae, 84; tarsi II, 9 and III, 21. First genital segment beneath a little impressed basally, especially on the sides. Pronotum large, wider than long (85: 72), with median carina, broadly rounded behind, covering most of metanatum (*sic*).

"*Female:* Antennal hairs and measurements almost identical with male. Pronotum large, covering most of mesonotum, with feeble median carina, wider than long (92: 70). Abdomen more sharply narrowed on basal part, narrow and nearly parallel on last three segments; connexiva moderately wide, reflexed almost vertically, with upper edge subparallel on last three segments. Anterior trochanters unarmed. Measurements of middle femora, 120; tibiae 102; tarsi II, 45 and III, 56. Hind femora incrassate but not as thick as in male, with similar armature; tibiae as in male; tarsi II, 6 and III, 20.

"*Macropters* form: Pronotum with distinct median carina; humeral angles a little elevated; hind triangular part with apex rounded; very little wider than long (110: 100). Hemelytra dark fuscous with veins darker, longer than abdomen. Male not quite as broad as female. Length, 3.23 mm.; width, 1.38 mm.

"*Holotype* (male) and *allotype* (female), both apteous, (*sic*) taken in a small stream, Barro Colorado, Canal Zone, Panama, Feb. 6-8, 1939, C. J. Drake. Paratypes: 1 apterous and 1 alate male, 2 alate and 6 apterous females taken with type.

"The color, markings and armature of hind legs separate this species from *R. femoralis*, Champion."

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PLATE I

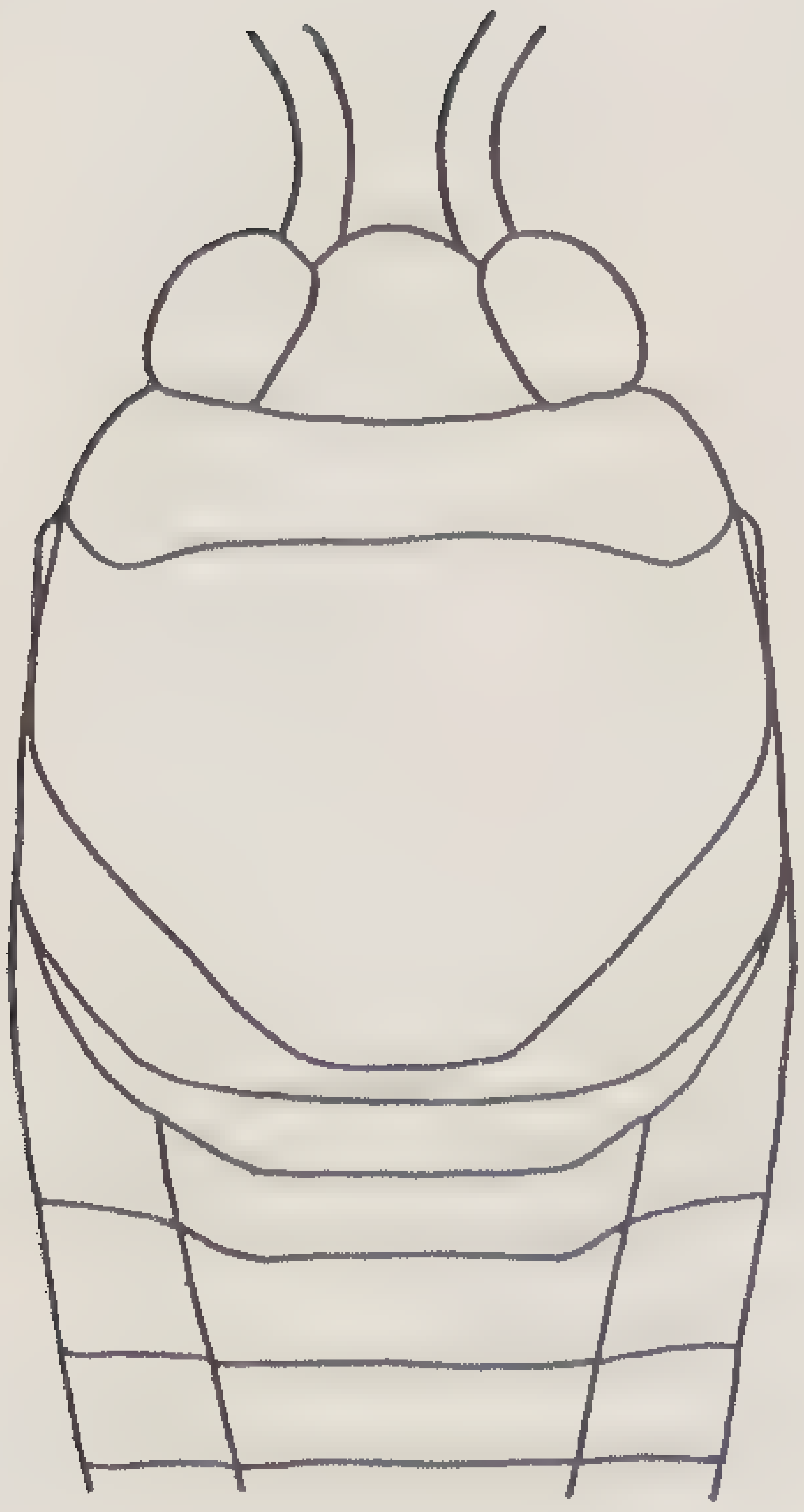
FIG. 1. Sutured off pronotum of angustipes group, dorsal view.

FIG. 2. Abbreviated pronotum of abrupta group, dorsal view.

FIG. 3. Pronotum covering mesonotum, dorsal view.

FIG. 4. Head, pro-, and mesothorax, showing minute, conical, black setae on base of jugum of head and proepisternum, ventral view.

PLATE I



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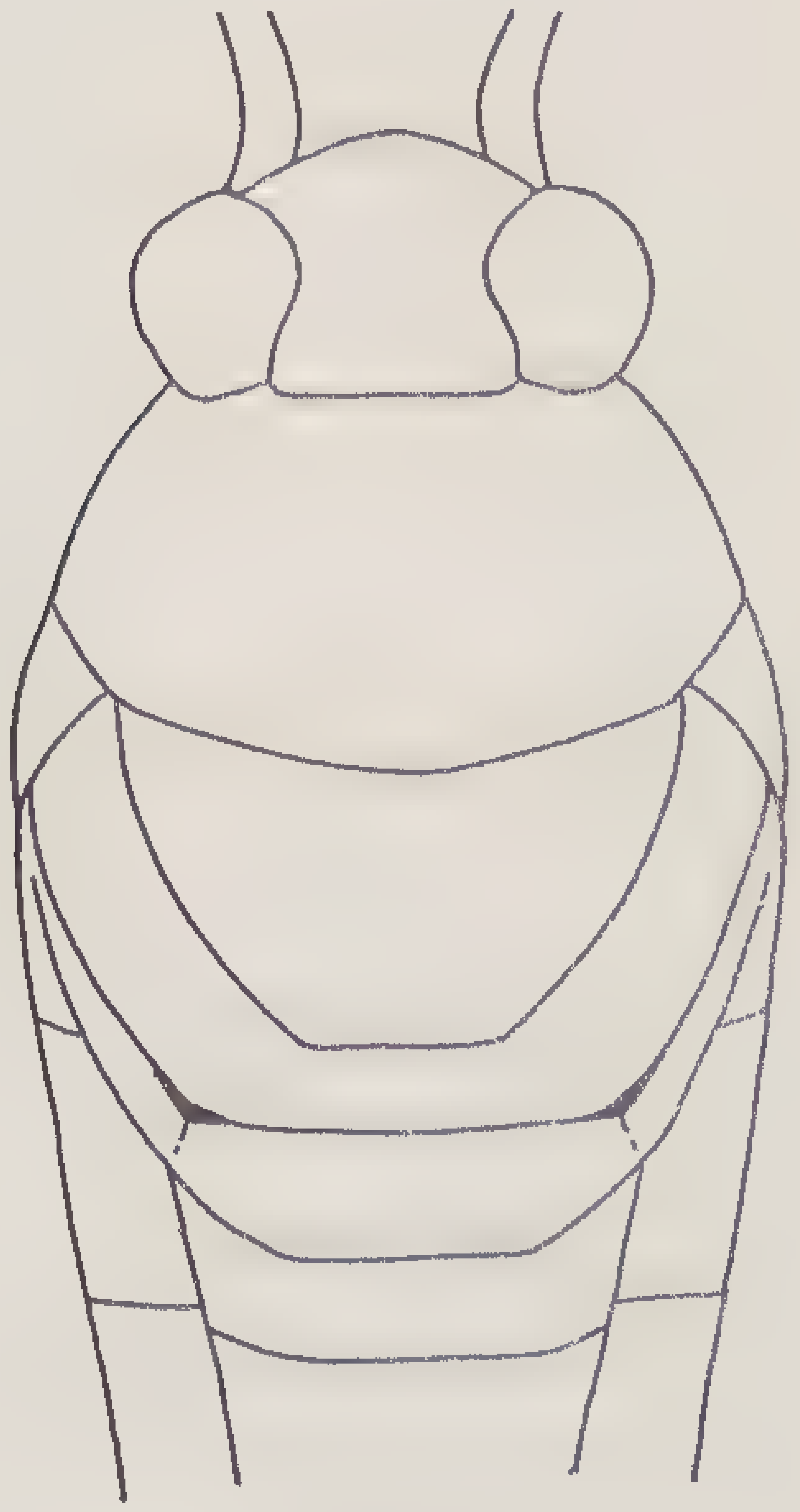

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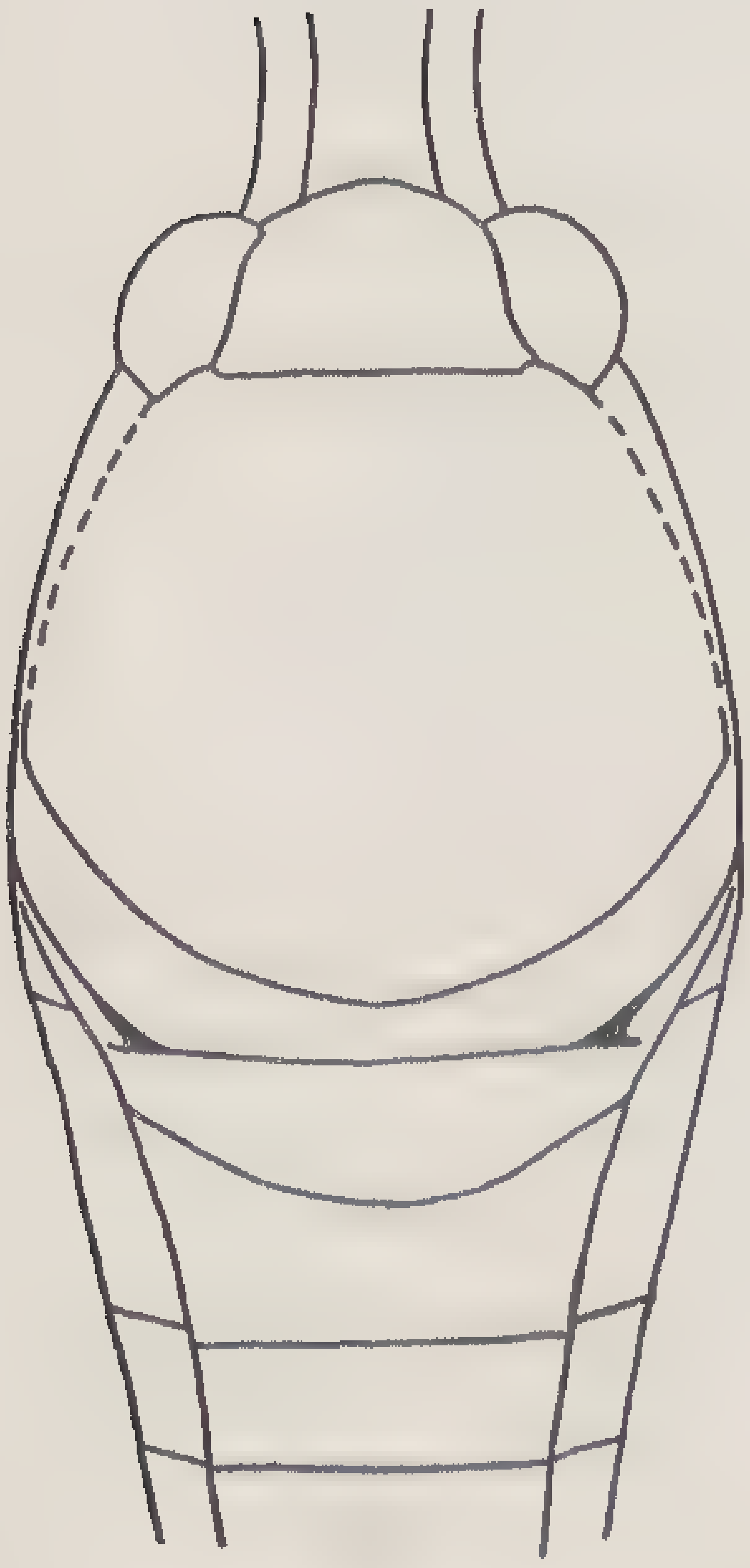

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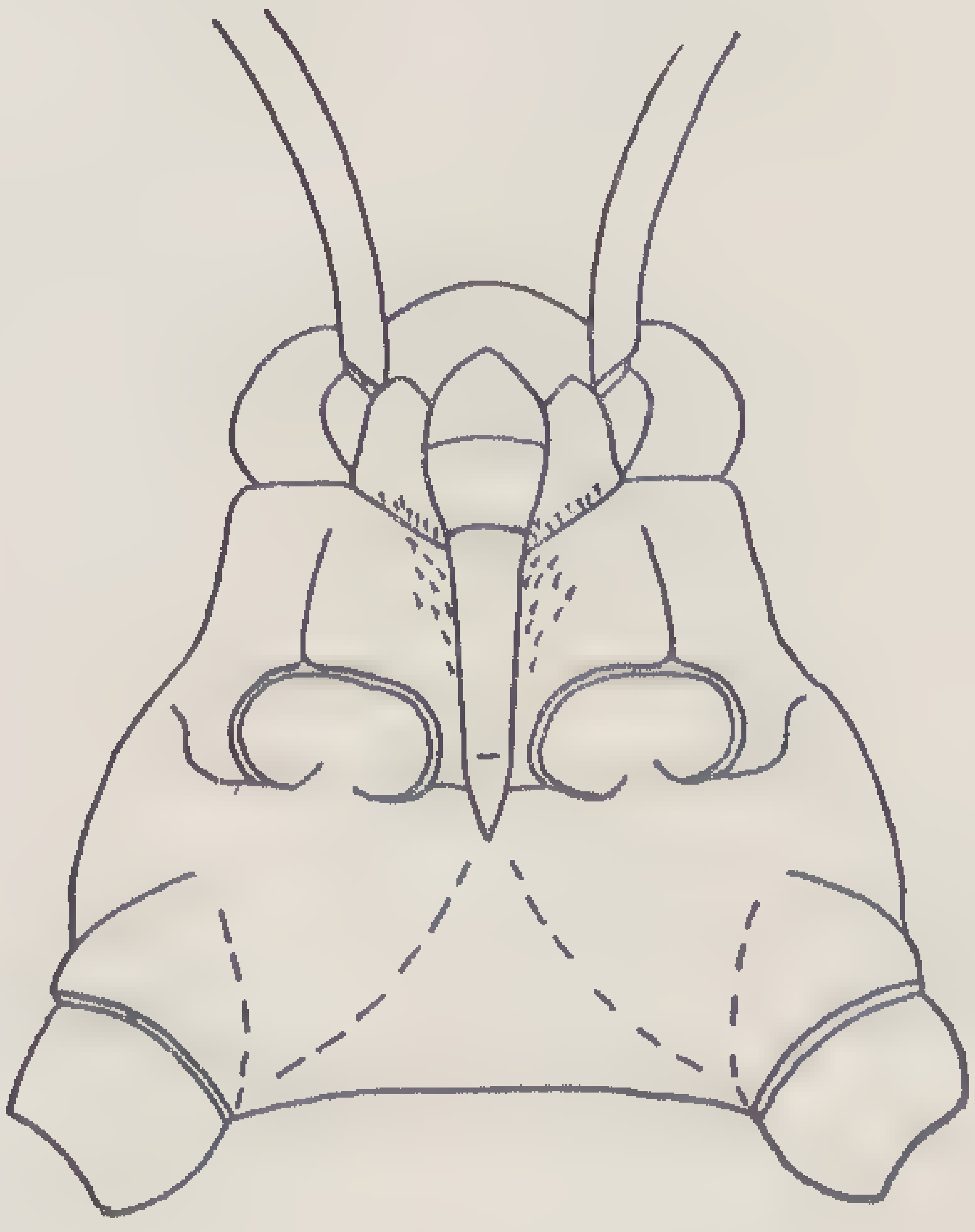

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PLATE II

FIG. 1. Dorsum of abdomen of apterous female tapered evenly.

FIG. 2. Dorsum of abdomen of apterous female narrowed after first three segments.

FIG. 3. Front tibia excavate and expanded, lateral view.

FIG. 4. Intermediate femur of female constricted near middle, lateral view.

FIG. 5. Intermediate femur of female flattened from basal one fourth to apical one fourth, lateral view.

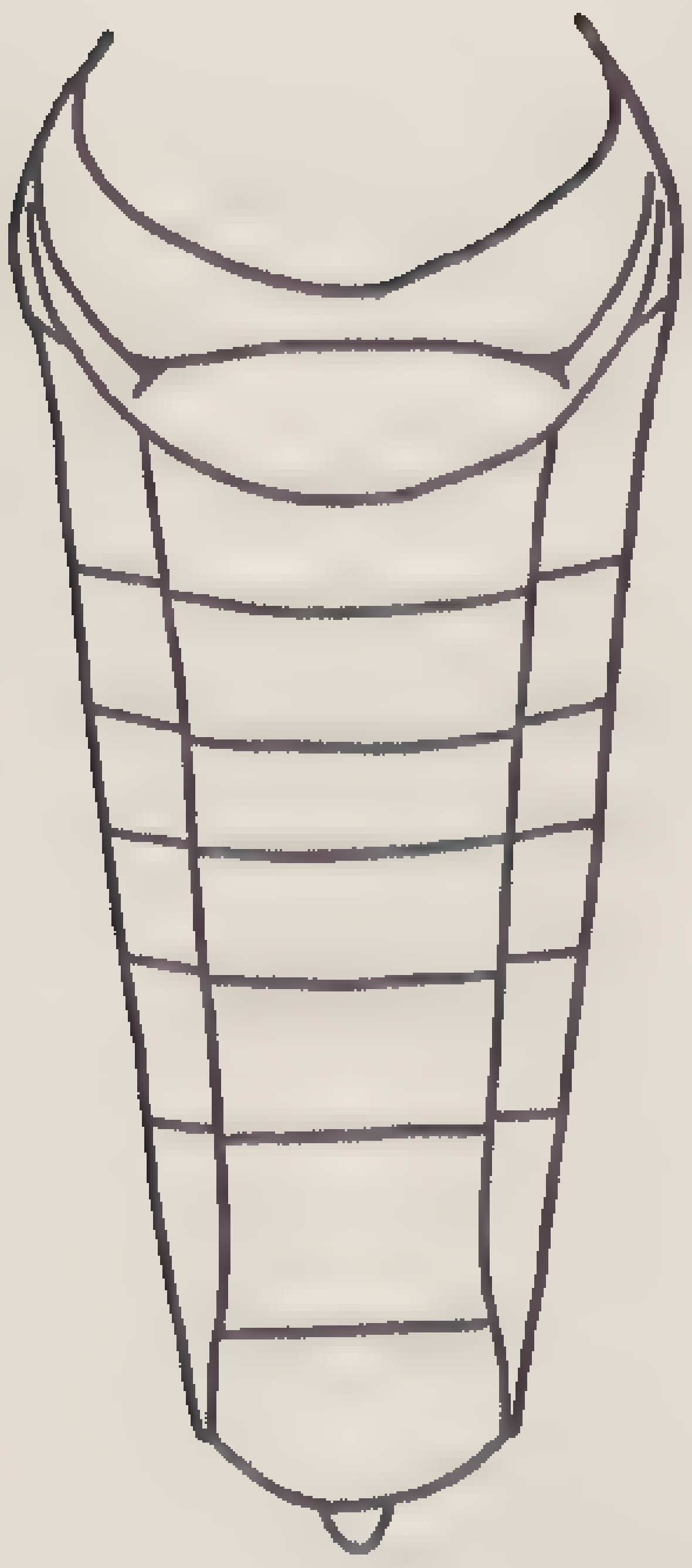
FIG. 6. Normal femur of female, lateral view.

FIG. 7. Posterior femur armed at apex with hook; elegans group.

FIG. 8. Mucronate last genital segment of female, dorsal view.

FIG. 9. Mucronate last genital segment of male, dorsal view.

PLATE II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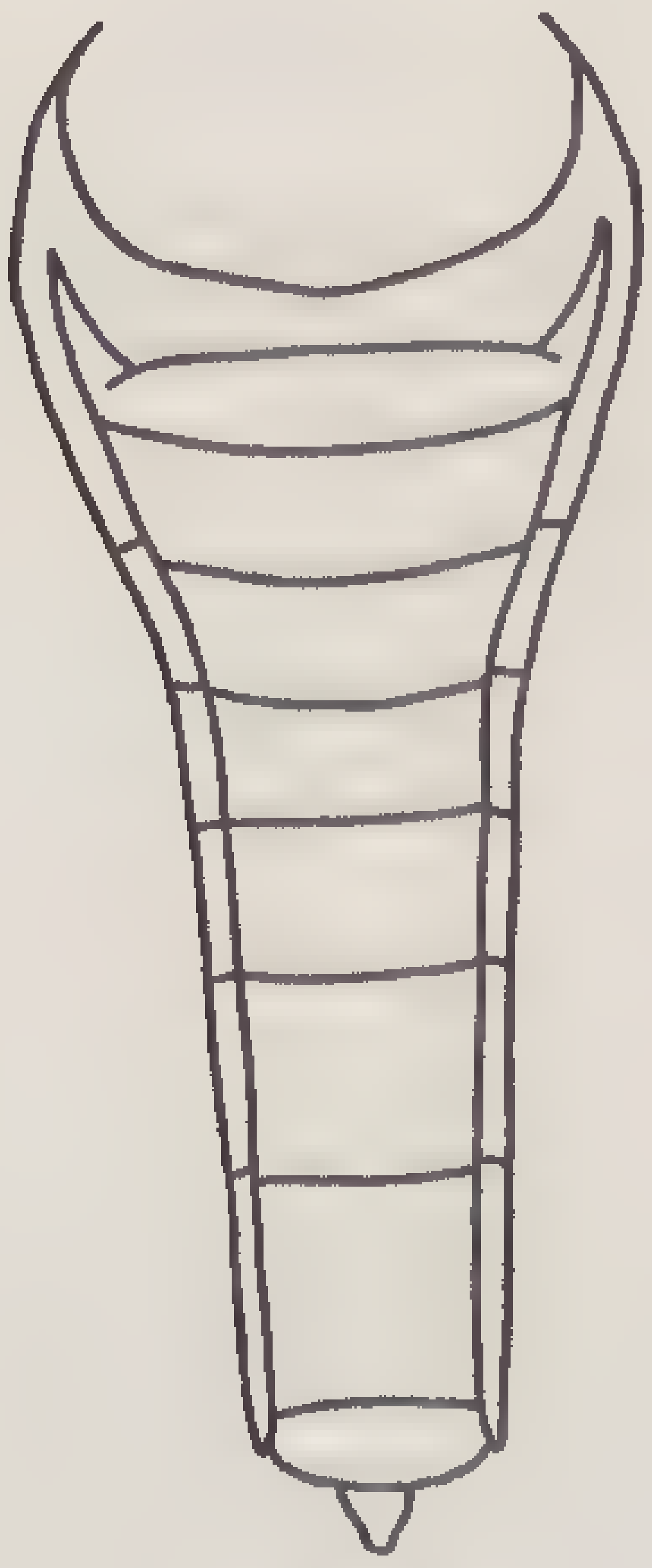
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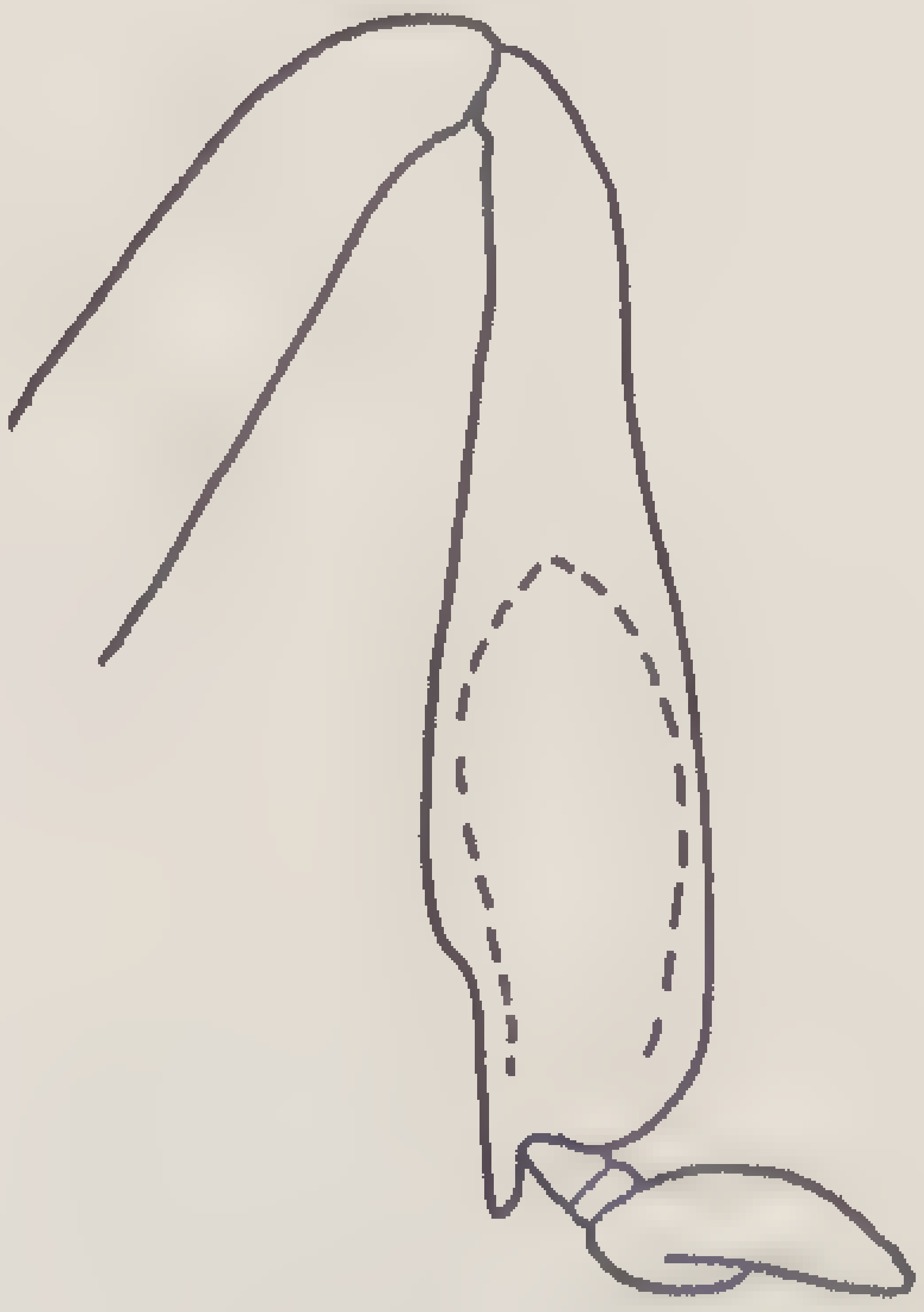
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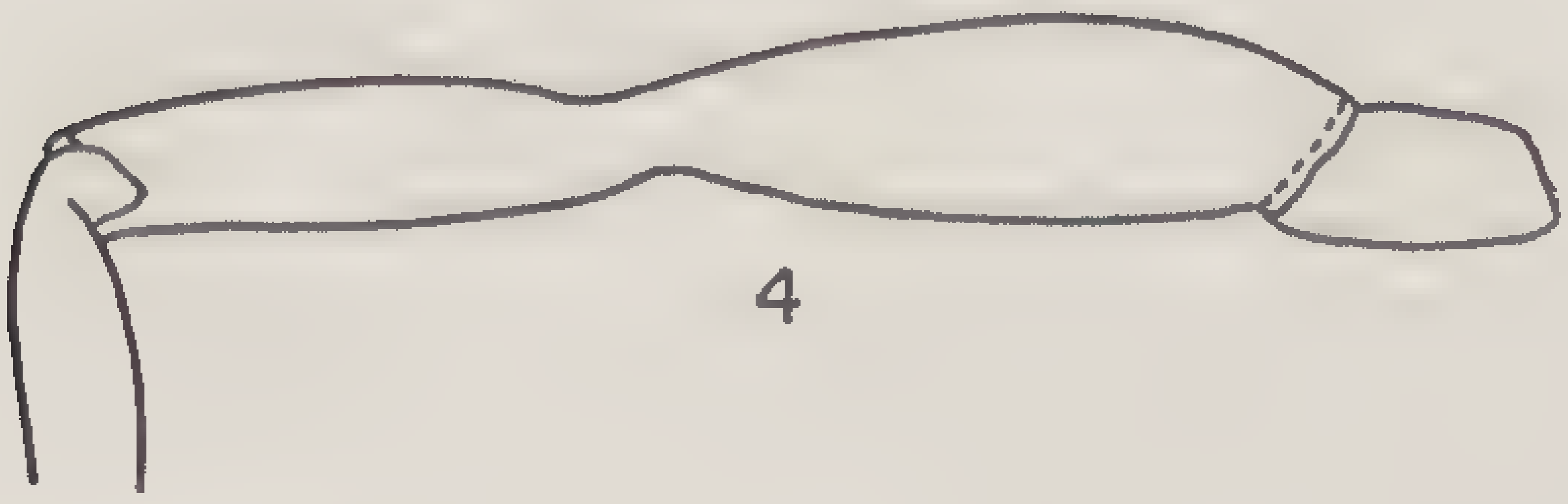
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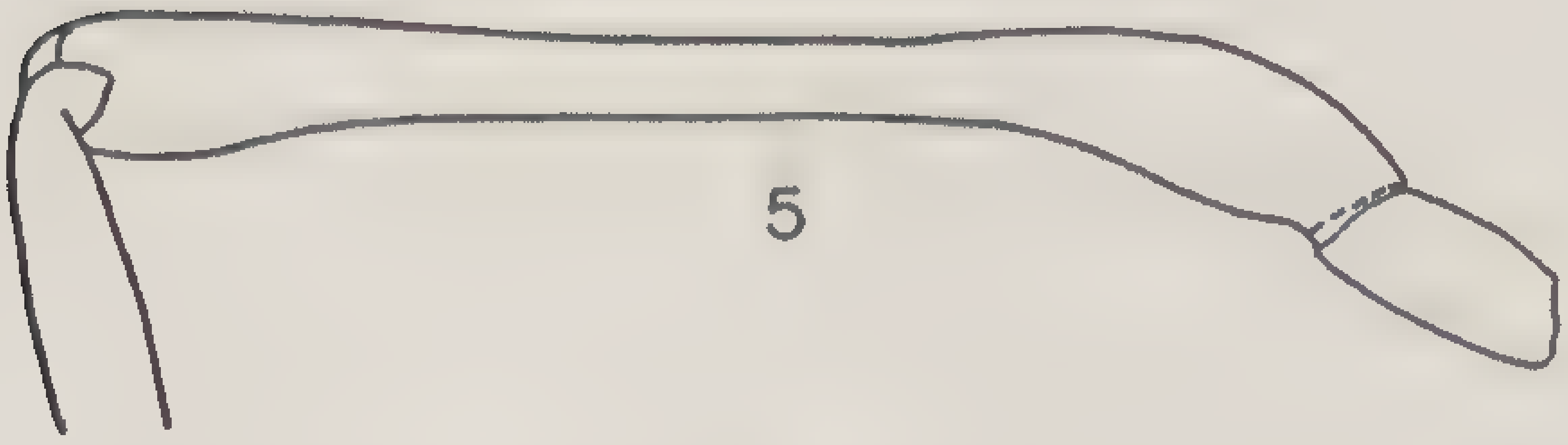
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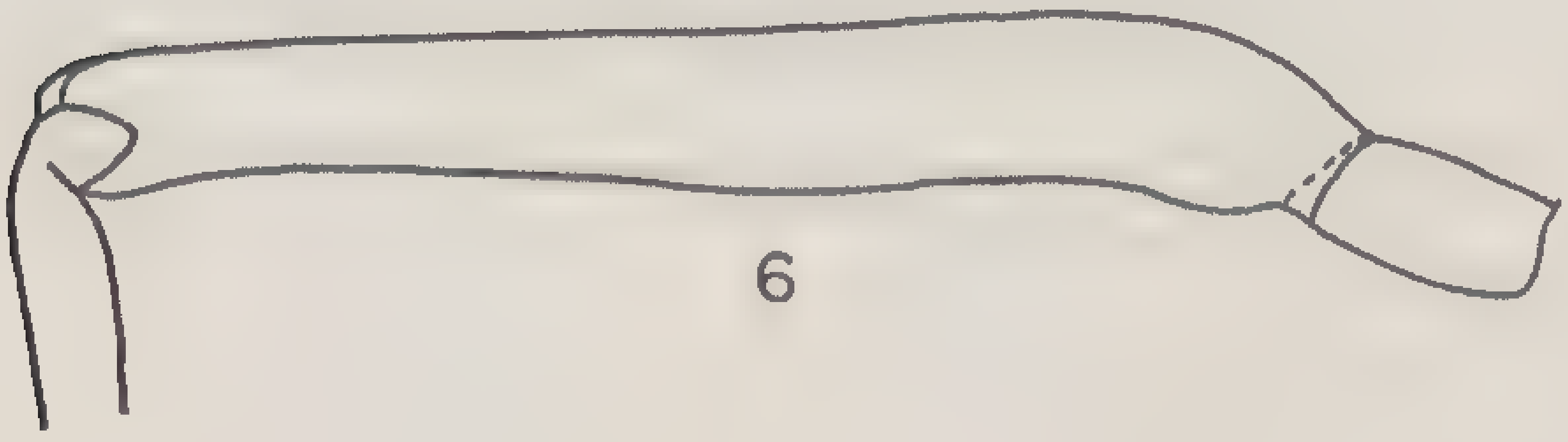
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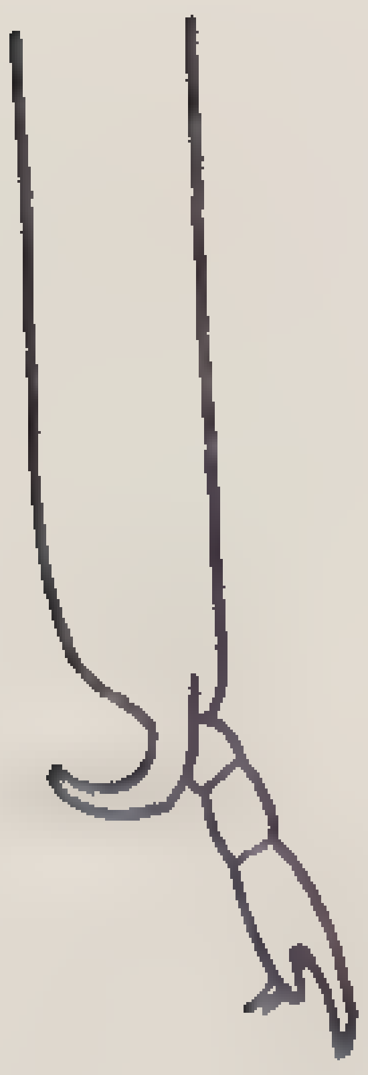
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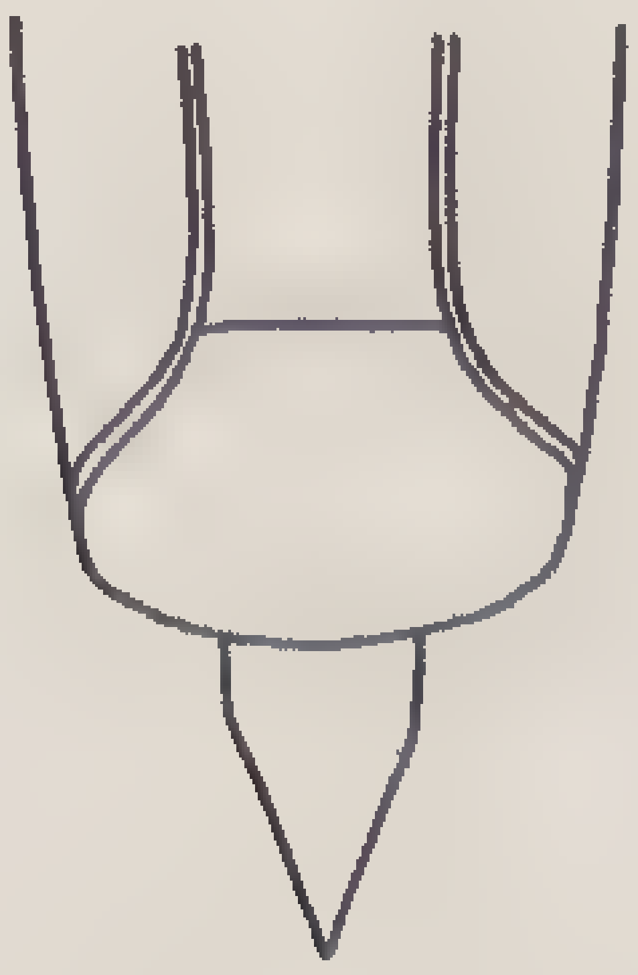
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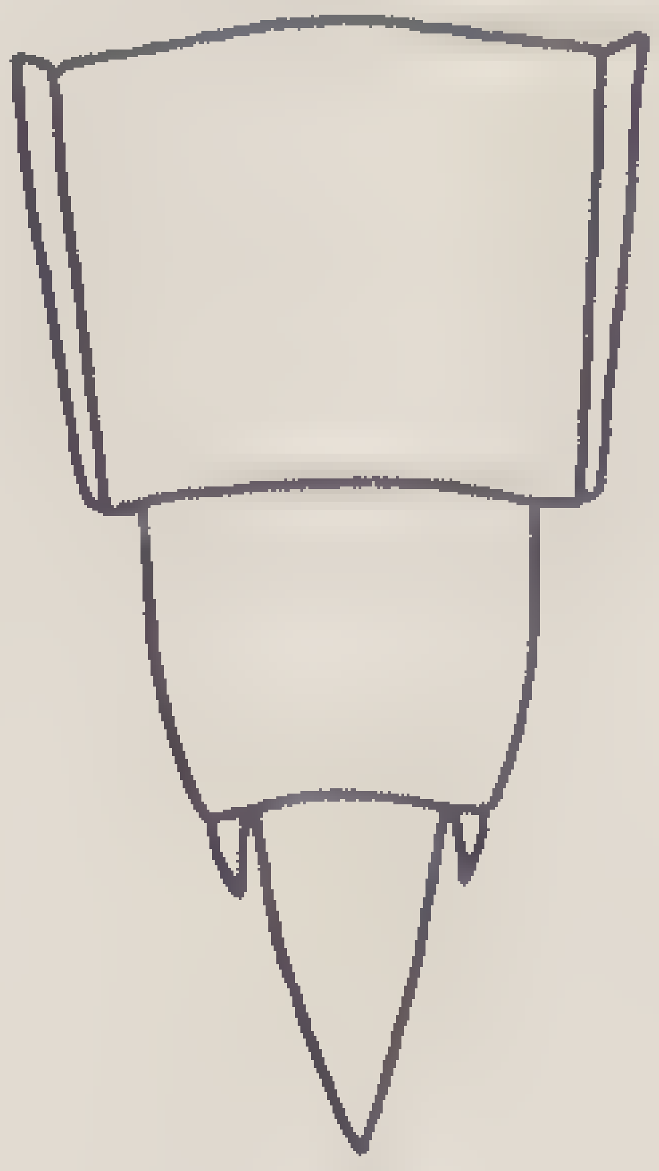
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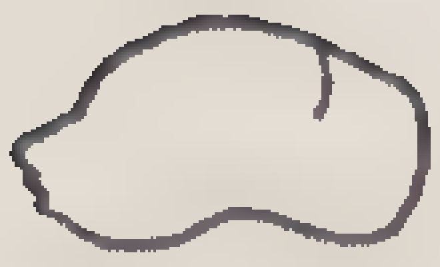
PLATE III

FIG. 1. *Rhagovelia angustipes* Uhler; right clasper, lateral view.
FIG. 2. *Rhagovelia bisignata* Bacon; right clasper, lateral view.
FIG. 3. *Rhagovelia callida* Drake and Harris; right clasper, lateral view.
FIG. 4. *Rhagovelia calopa* Drake and Harris; right clasper, lateral view.
FIG. 5. *Rhagovelia deminuta* Bacon; right clasper, lateral view.
FIG. 6. *Rhagovelia evidis* Bacon; right clasper, lateral view.
FIG. 7. *Rhagovelia fontanalis* Bacon; right clasper, lateral view.
FIG. 8. *Rhagovelia hambletoni* Drake and Harris; right clasper, lateral view.
FIG. 9. *Rhagovelia imitatrix* Bacon; right clasper, lateral view.
FIG. 10. *Rhagovelia longipes* Gould; right clasper, lateral view.
FIG. 11. *Rhagovelia modesta* Bacon; right clasper, lateral view.
FIG. 12. *Rhagovelia plana* Drake and Harris; right clasper, lateral view.
FIG. 13. *Rhagovelia plumbea* Uhler; right clasper, lateral view.
FIG. 14. *Rhagovelia salina* (Champion); right clasper, lateral view.
FIG. 15. *Rhagovelia spinosa* Gould; right clasper, lateral view.
FIG. 16. *Rhagovelia tantilla* Drake and Harris; right clasper, lateral view.
FIG. 17. *Rhagovelia tenuipes* Champion; right clasper, lateral view.
FIG. 18. *Rhagovelia velocis* Drake and Harris; right clasper, lateral view.
FIG. 19. *Rhagovelia versuta* Drake and Harris; right clasper, lateral view.
FIG. 20. *Rhagovelia paulana* Drake; right clasper, lateral view.
FIG. 21. *Rhagovelia viriosa* Bacon; right clasper, lateral view.
FIG. 22. *Rhagovelia janeira* Drake; right clasper, lateral view.

PLATE III

ANGUSTIPES GROUP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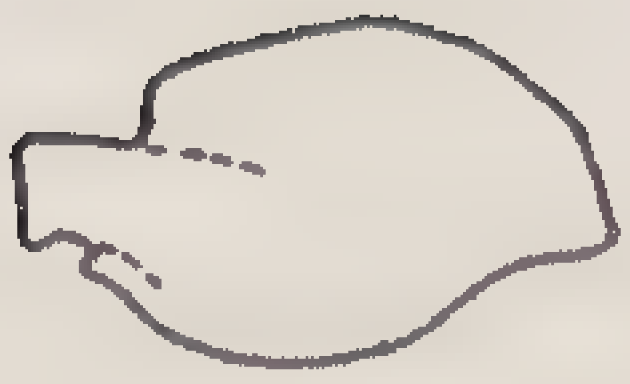
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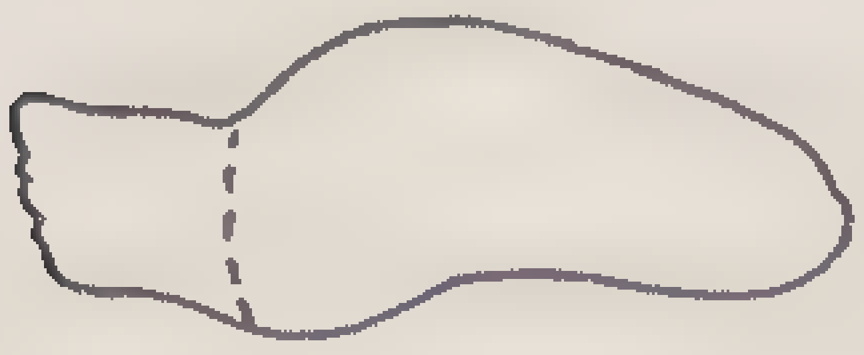
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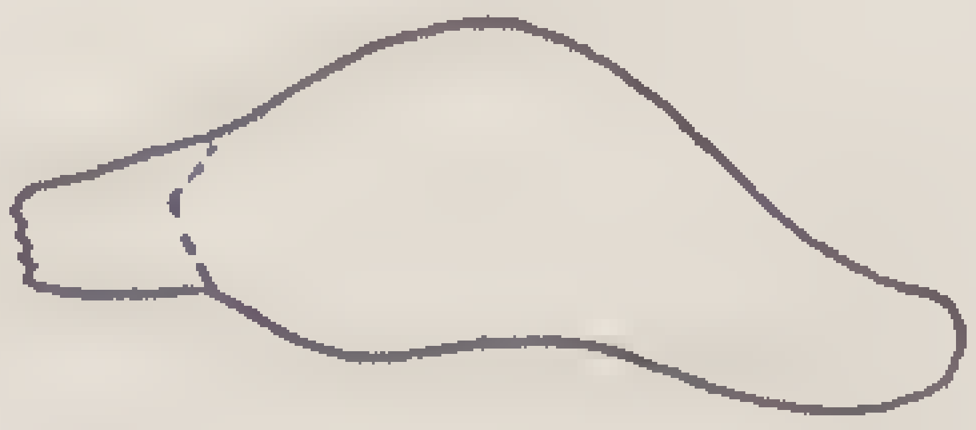
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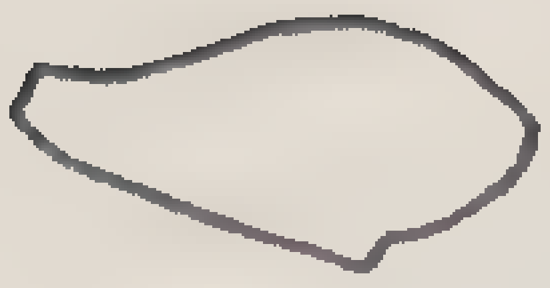
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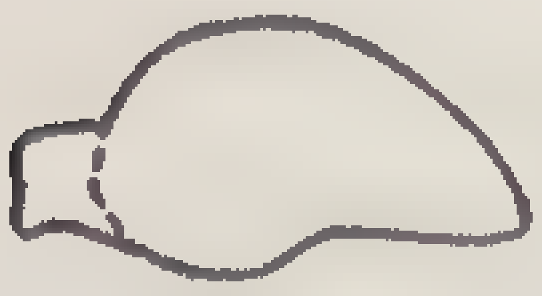
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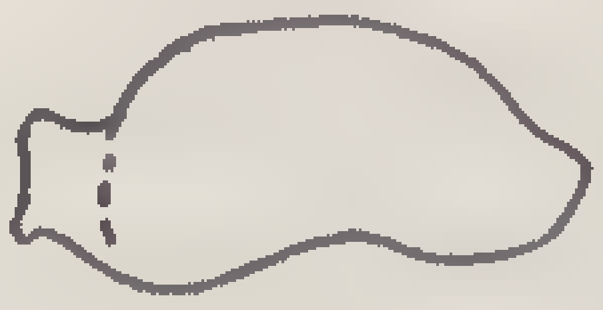
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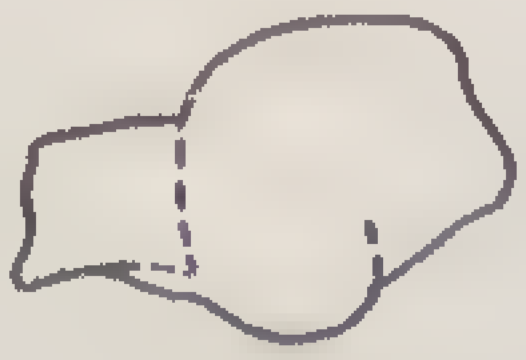
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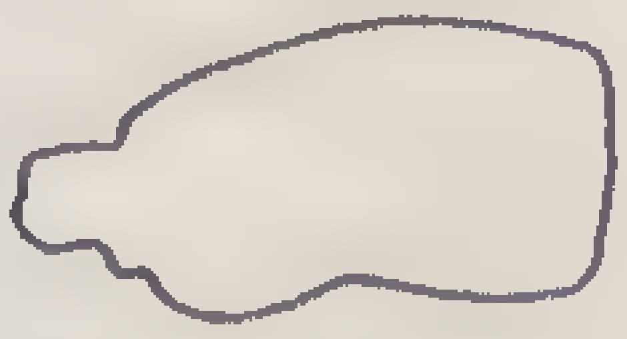
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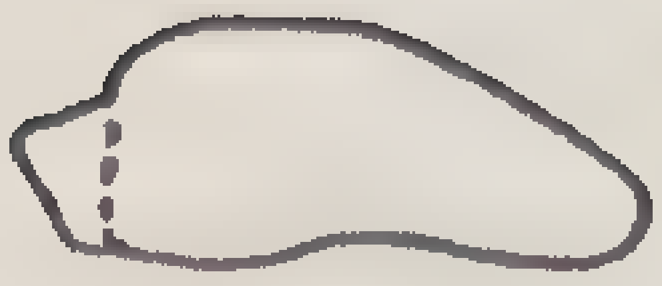
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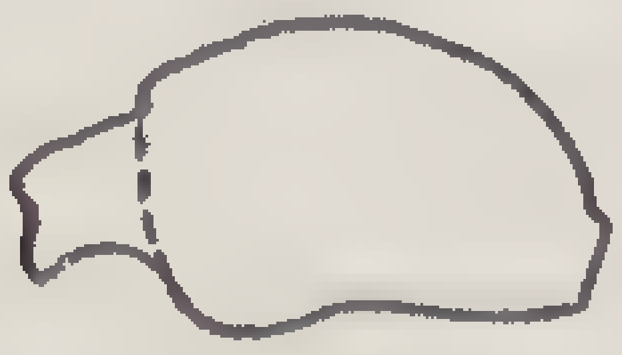
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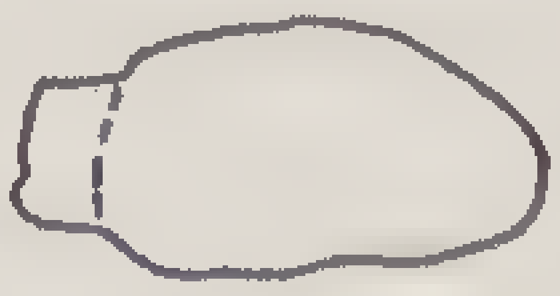
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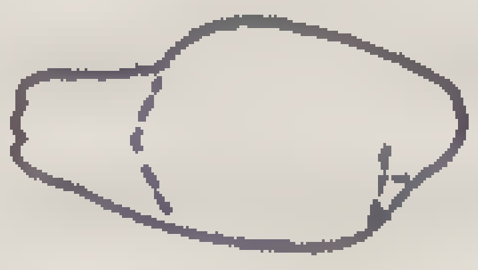
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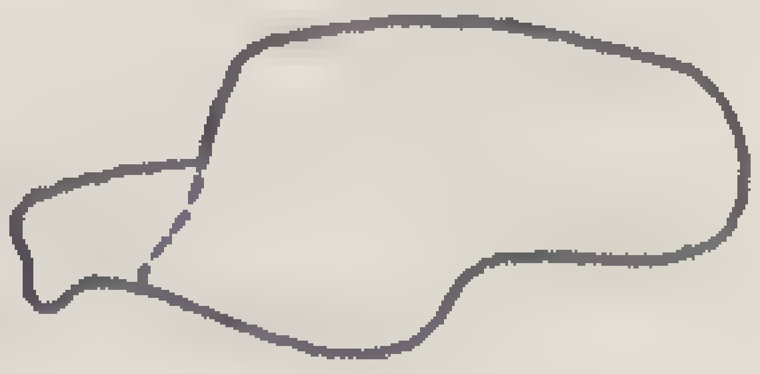
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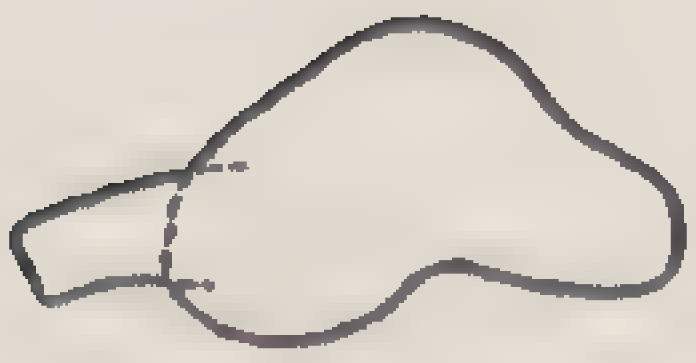
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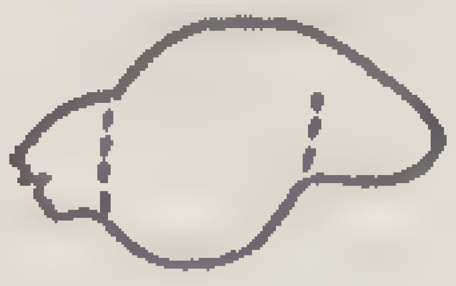
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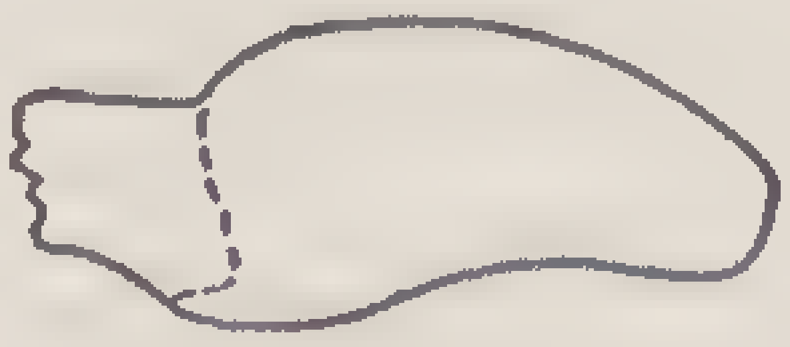
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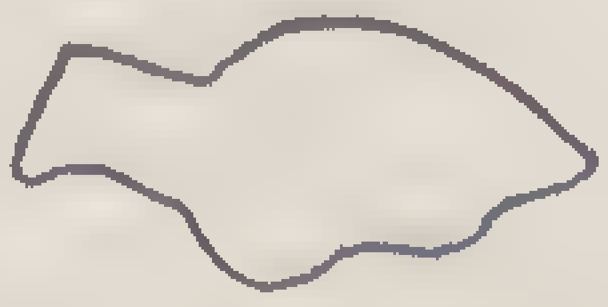
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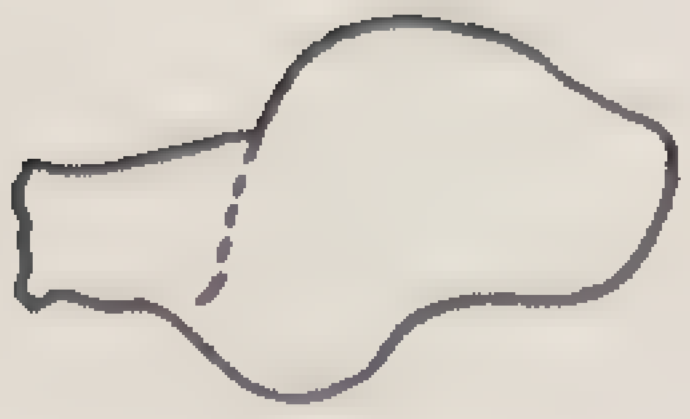
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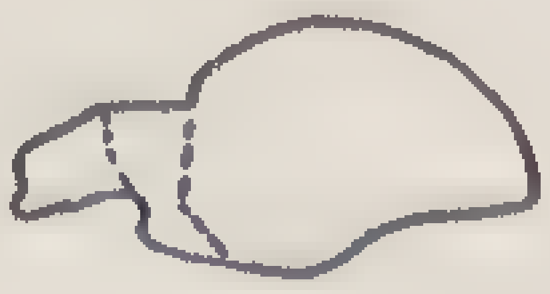
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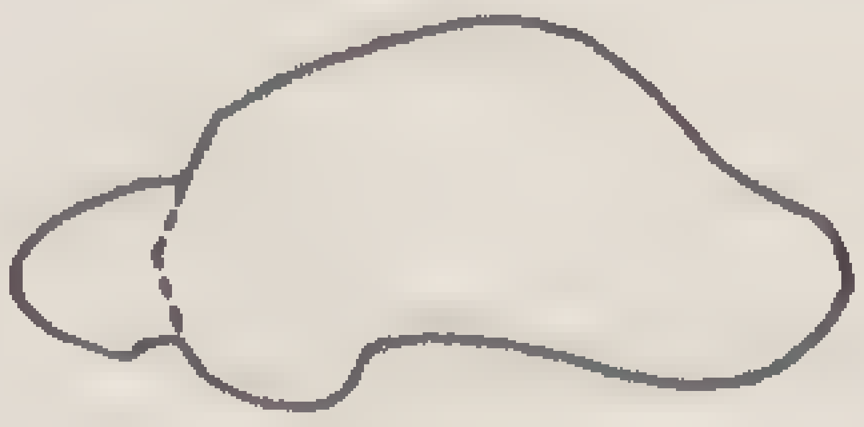
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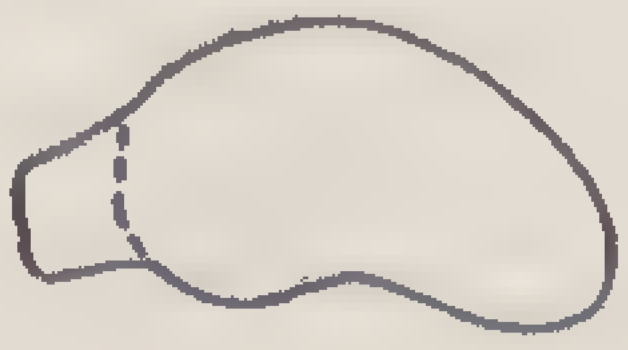
R. JANEIRA
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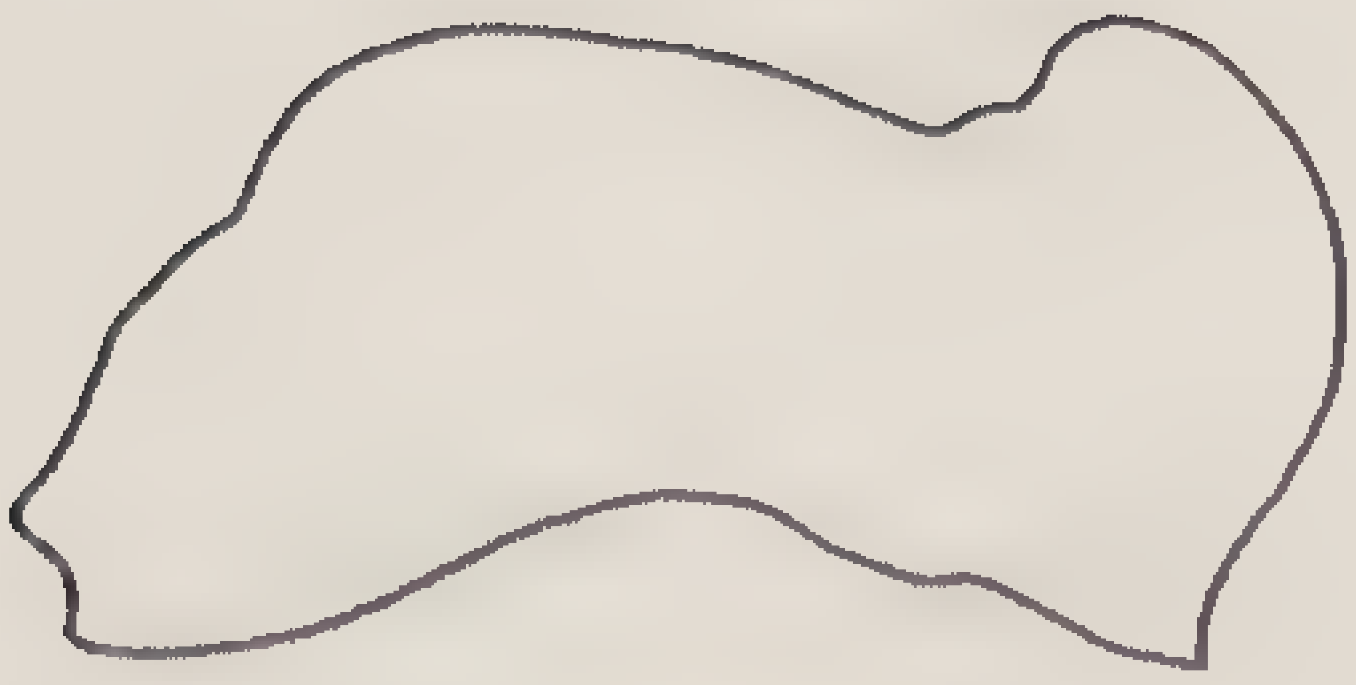
PLATE IV

FIG. 1. *Rhagovelia abrupta* Gould; right clasper, lateral view.
FIG. 2. *Rhagovelia lucida* Gould; right clasper, lateral view.
FIG. 3. *Rhagovelia torquata* Bacon; right clasper, lateral view.
FIG. 4. *Rhagovelia trepida* Bacon; right clasper, lateral view.
FIG. 5. *Rhagovelia trista* Gould; right clasper, lateral view.
FIG. 6A. *Rhagovelia vivata* Bacon; right clasper, lateral view.
FIG. 6B. *Rhagovelia vivata* Bacon; right clasper, dorsal view.
FIG. 7. *Rhagovelia elegans* Uhler; right clasper, lateral view.
FIG. 8. *Rhagovelia insularis* Champion; right clasper, lateral view.
FIG. 9. *Rhagovelia merga* Bacon; right clasper, lateral view.
FIG. 10. *Rhagovelia uncinata* Champion; right clasper, lateral view.

PLATE IV

ABRUPTA GROUP



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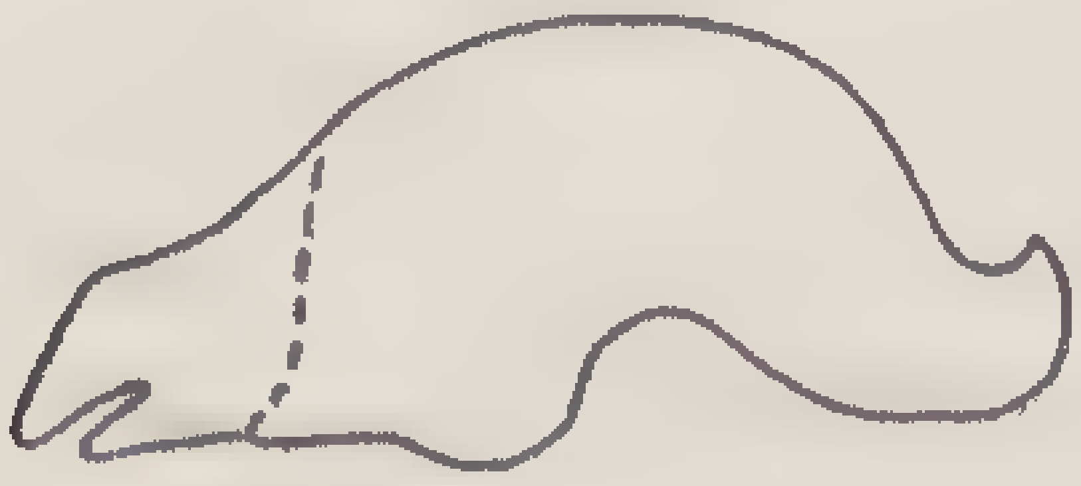

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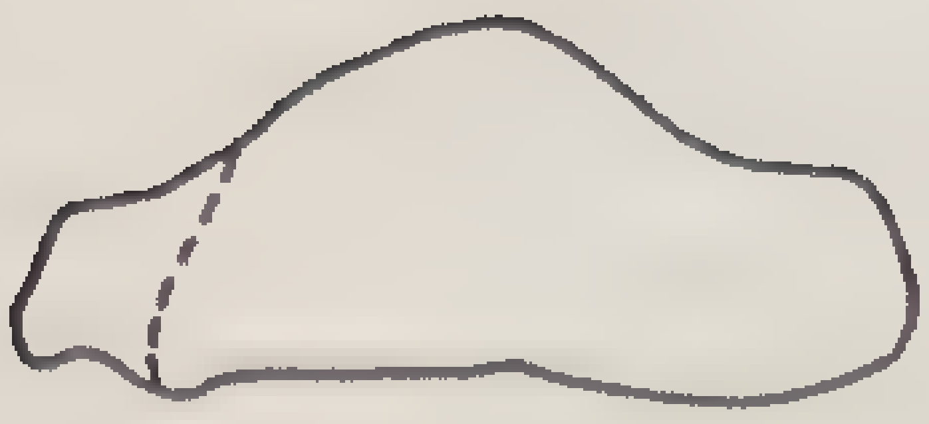

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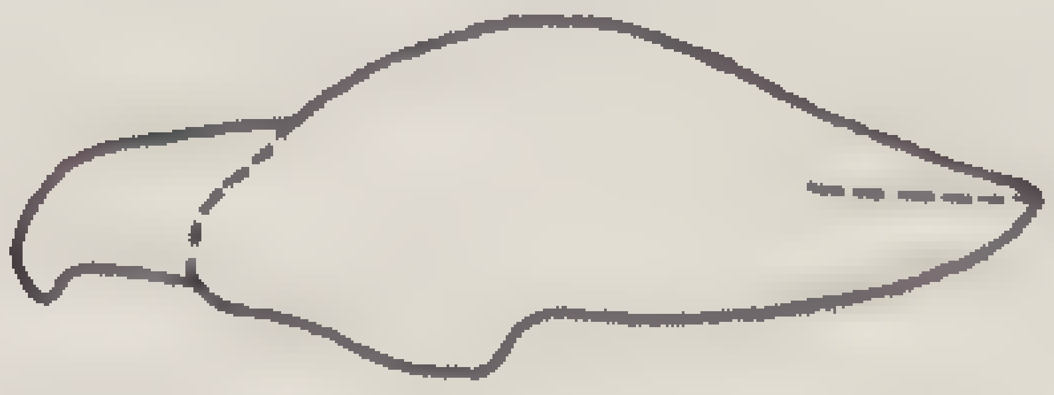

R. TREPIDA

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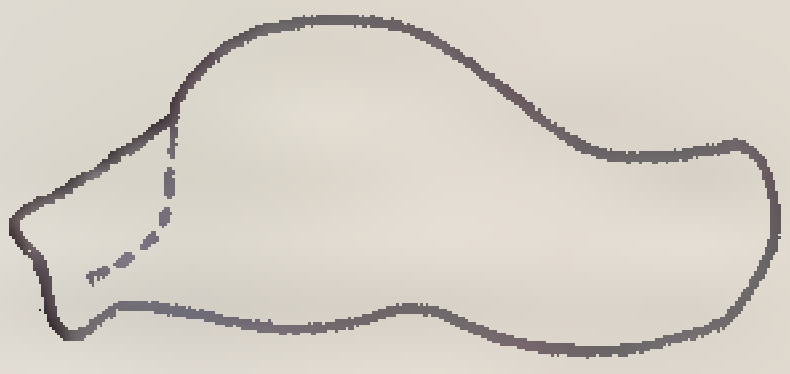

R. TRISTA

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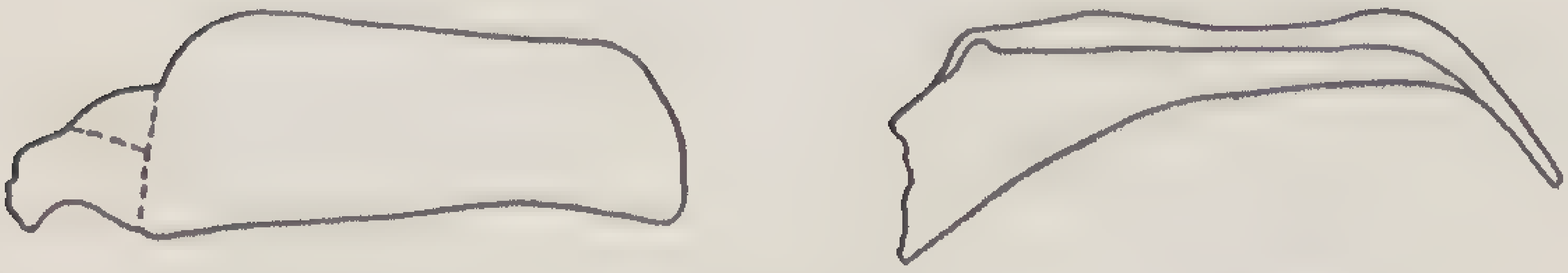


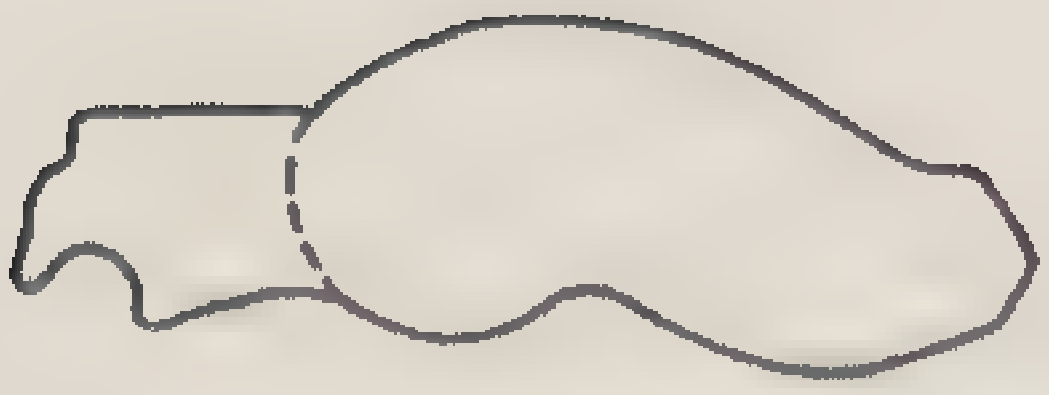
A

R. VIVATA

6

B

ELEGANS GROUP



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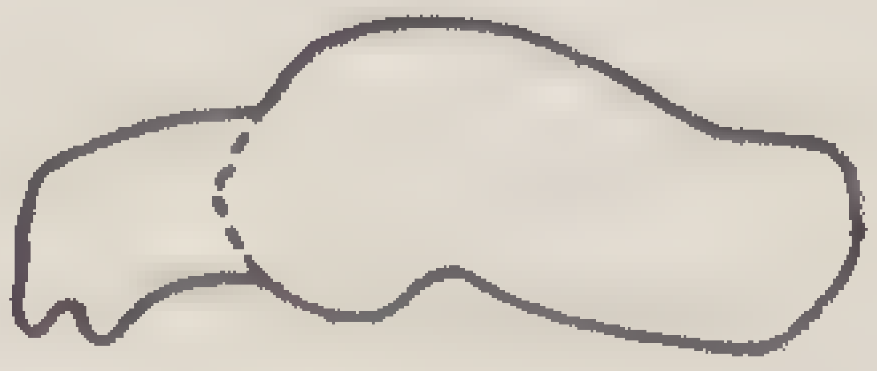

R. INSULARIS

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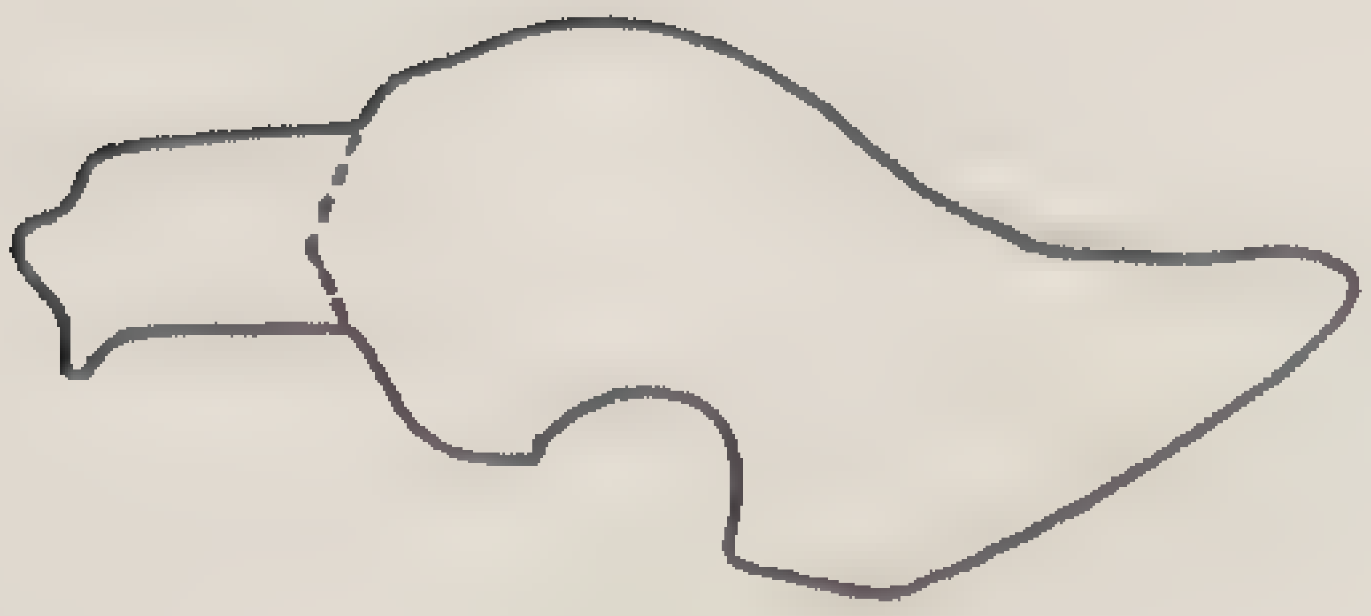

R. MERGA

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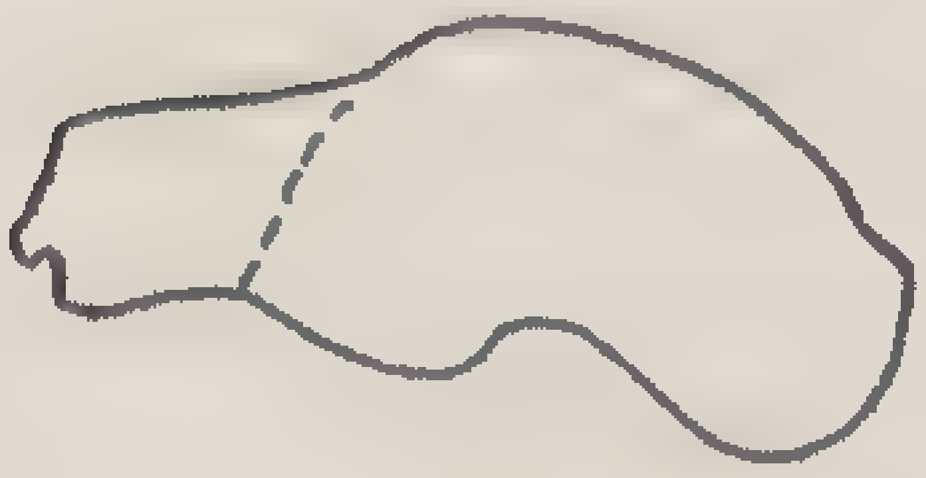


R. UNCINATA

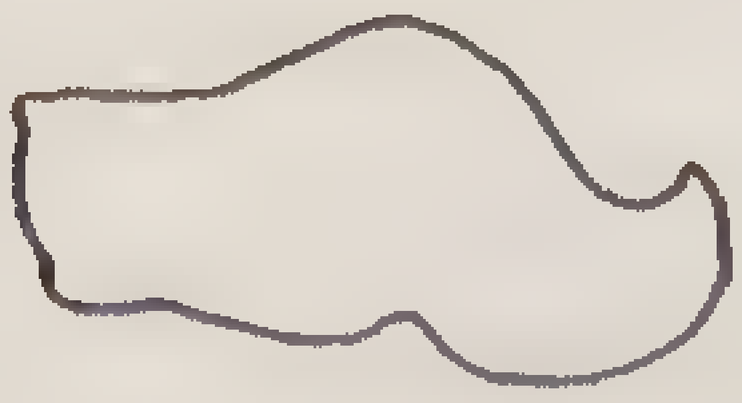
10

PLATE V

FIG. 1. *Rhagovelia amazonensis* Gould; right clasper, lateral view.
FIG. 2. *Rhagovelia castanea* Gould; right clasper, lateral view.
FIG. 3. *Rhagovelia crassipes* Champion; right clasper, lateral view.
FIG. 4. *Rhagovelia femoralis* Champion; right clasper, lateral view.
FIG. 5. *Rhagovelia horrida* Bacon; right clasper, lateral view.
FIG. 6. *Rhagovelia jubata* Bacon; right clasper, lateral view.
FIG. 7. *Rhagovelia nitida* Bacon; right clasper, lateral view.
FIG. 8. *Rhagovelia ornata* Bacon; right clasper, lateral view.
FIG. 9. *Rhagovelia palea* Bacon; right clasper, lateral view.
FIG. 10. *Rhagovelia perfidiosa* Bacon; right clasper, lateral view.
FIG. 11. *Rhagovelia relicta* Gould; right clasper, lateral view.
FIG. 12. *Rhagovelia robusta* Gould; right clasper, lateral view.
FIG. 13. *Rhagovelia scitula* Bacon; right clasper, lateral view.
FIG. 14. *Rhagovelia sinuata* Gould; right clasper, lateral view.
FIG. 15. *Rhagovelia varipes* Champion; right clasper, lateral view.
FIG. 16. *Rhagovelia whitei* (Breddin); right clasper, lateral view.
FIG. 17. *Rhagovelia williamsi* Gould; right clasper, lateral view.

PLATE V

CRASSIPES GROUP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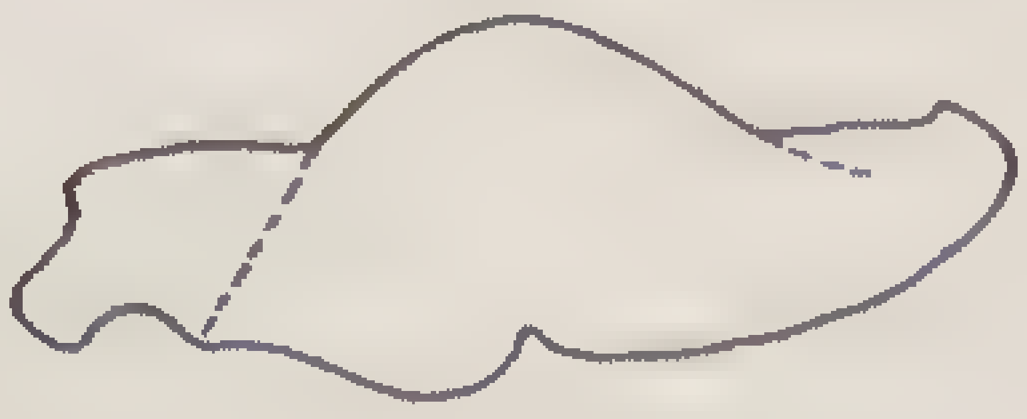
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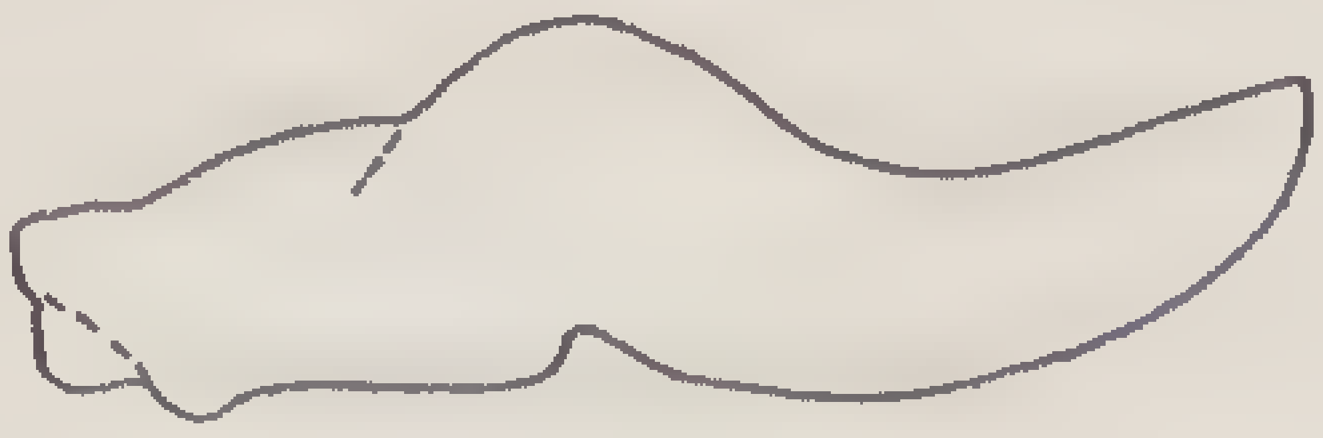
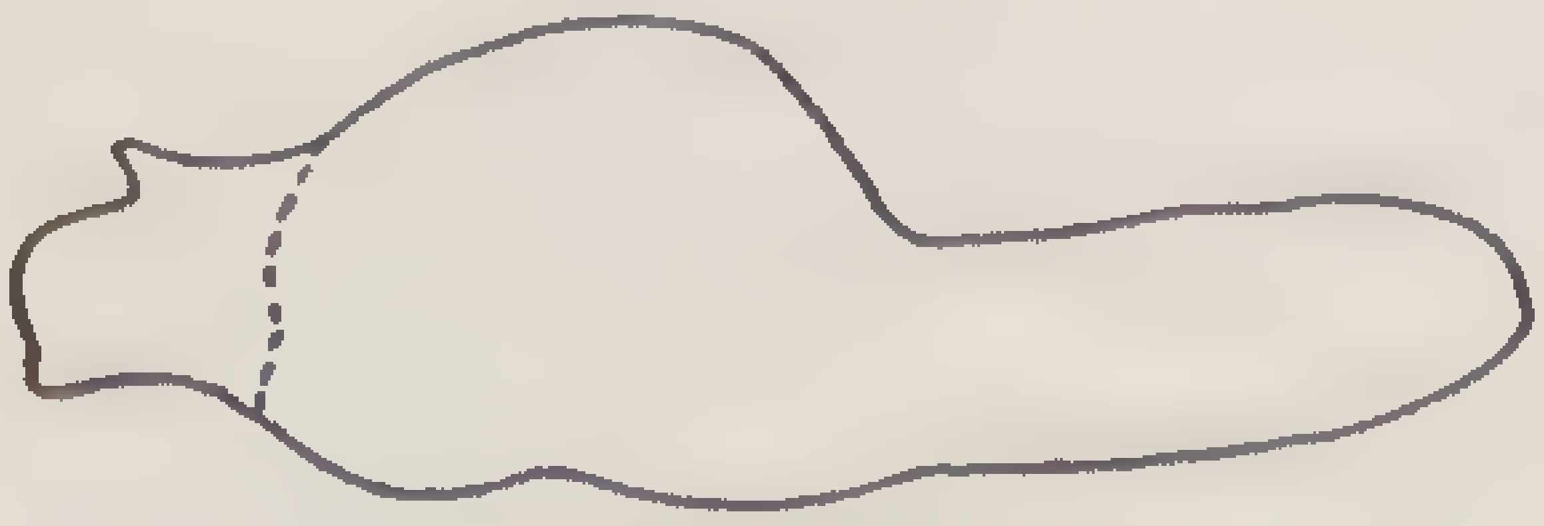

3 R. CRASSIPES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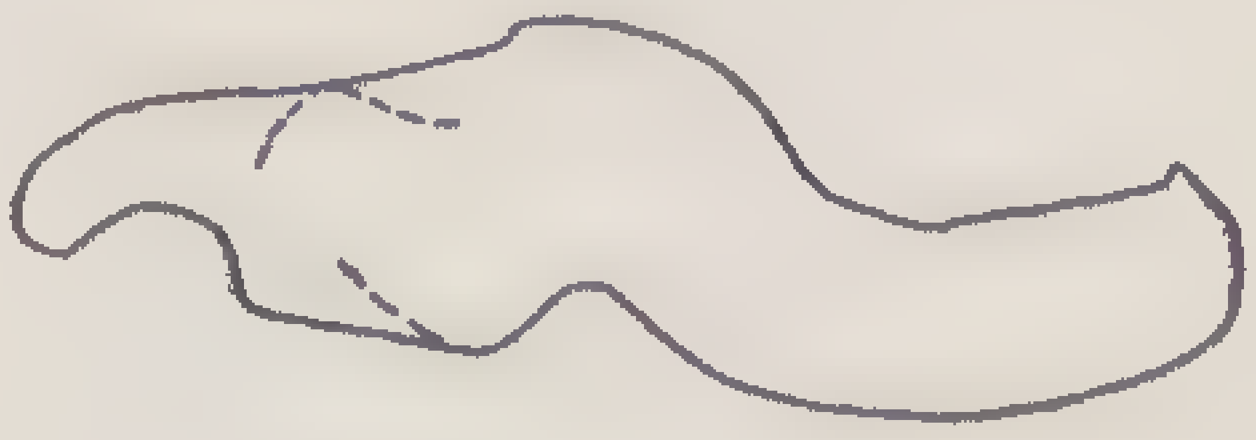
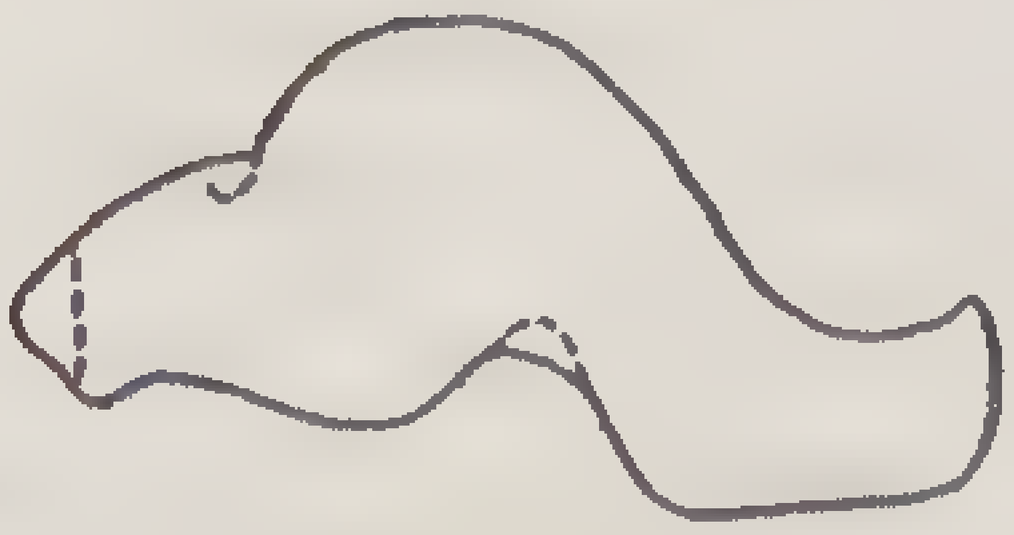

5 R. HORRIDA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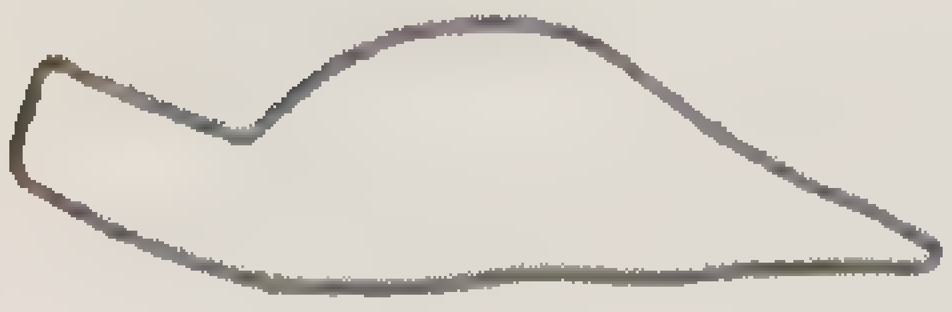
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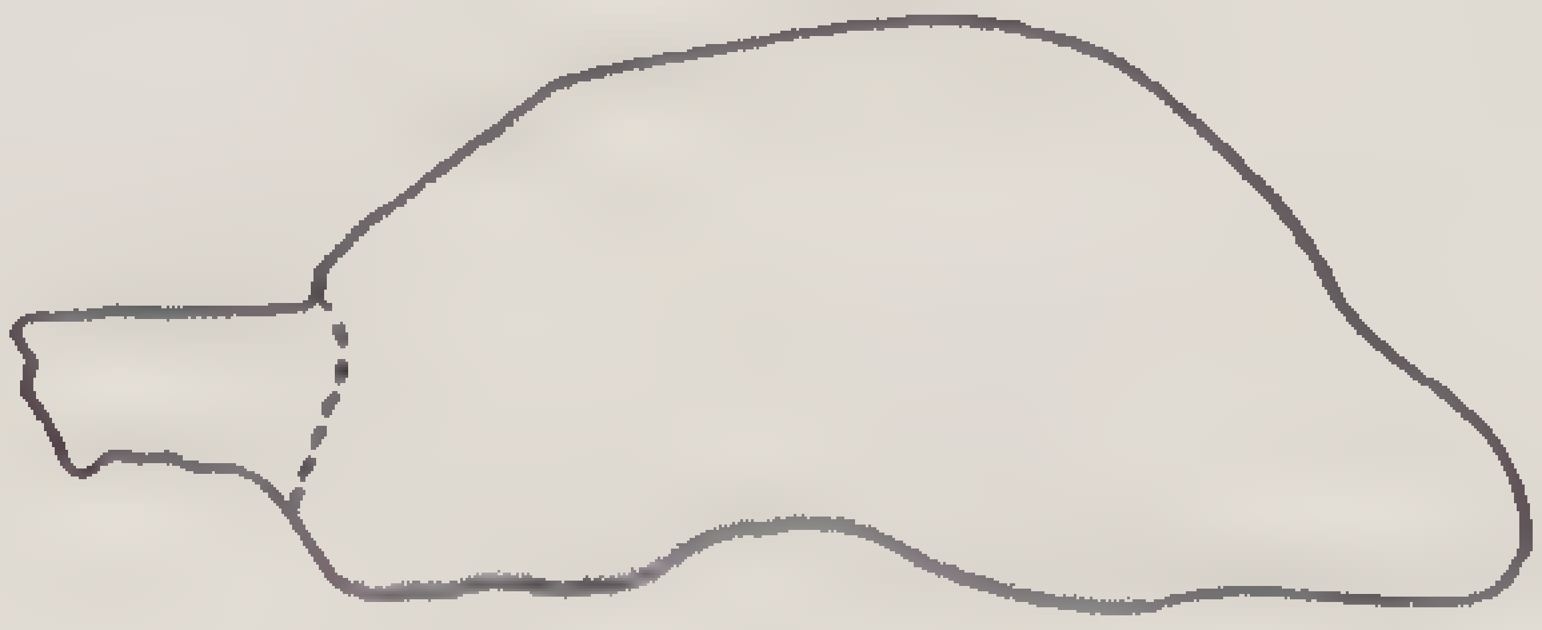
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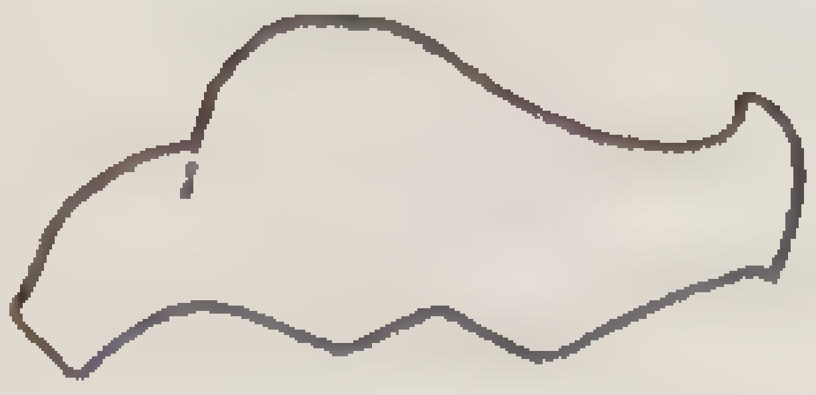
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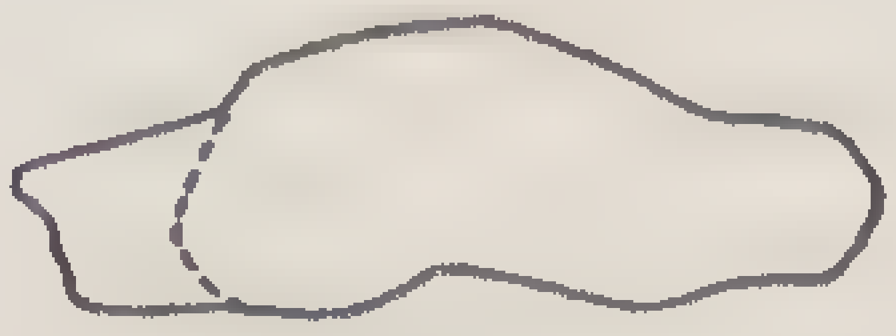
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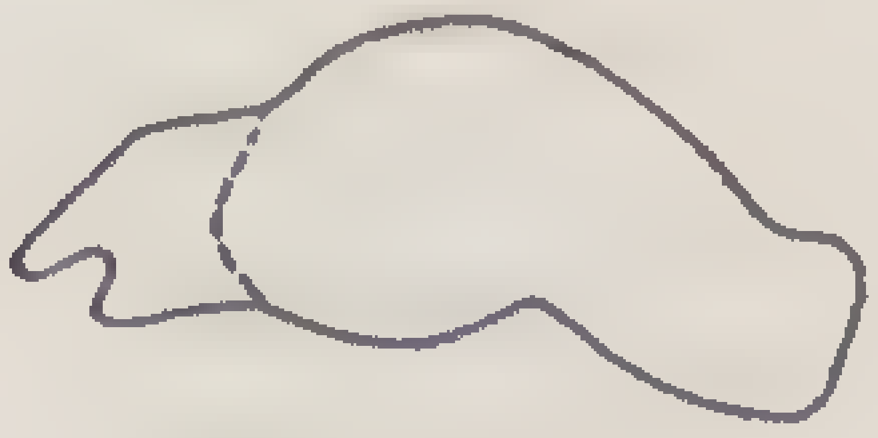
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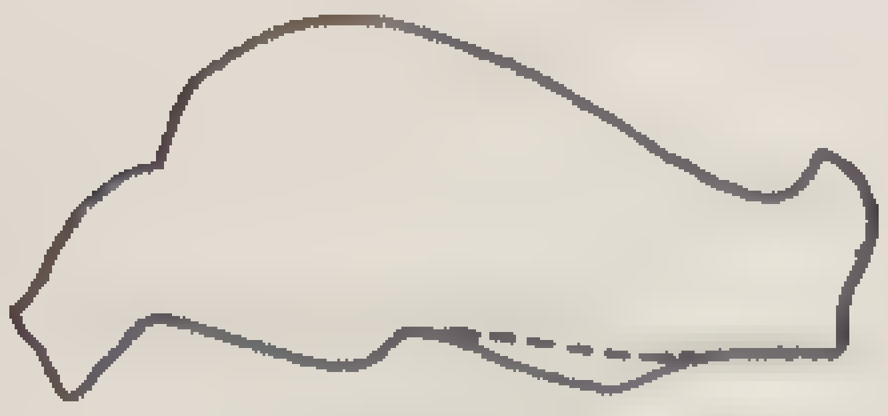
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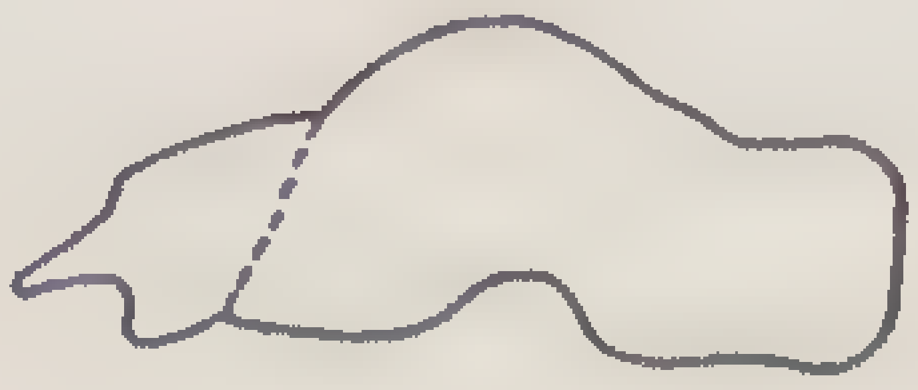
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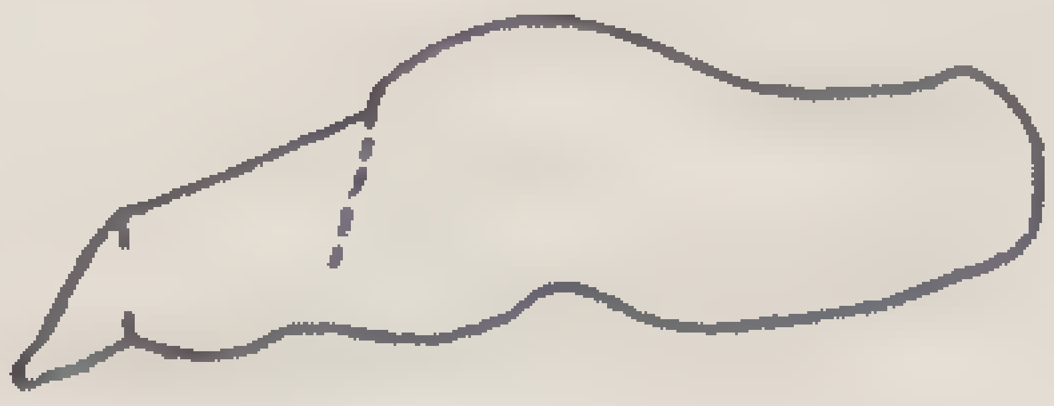
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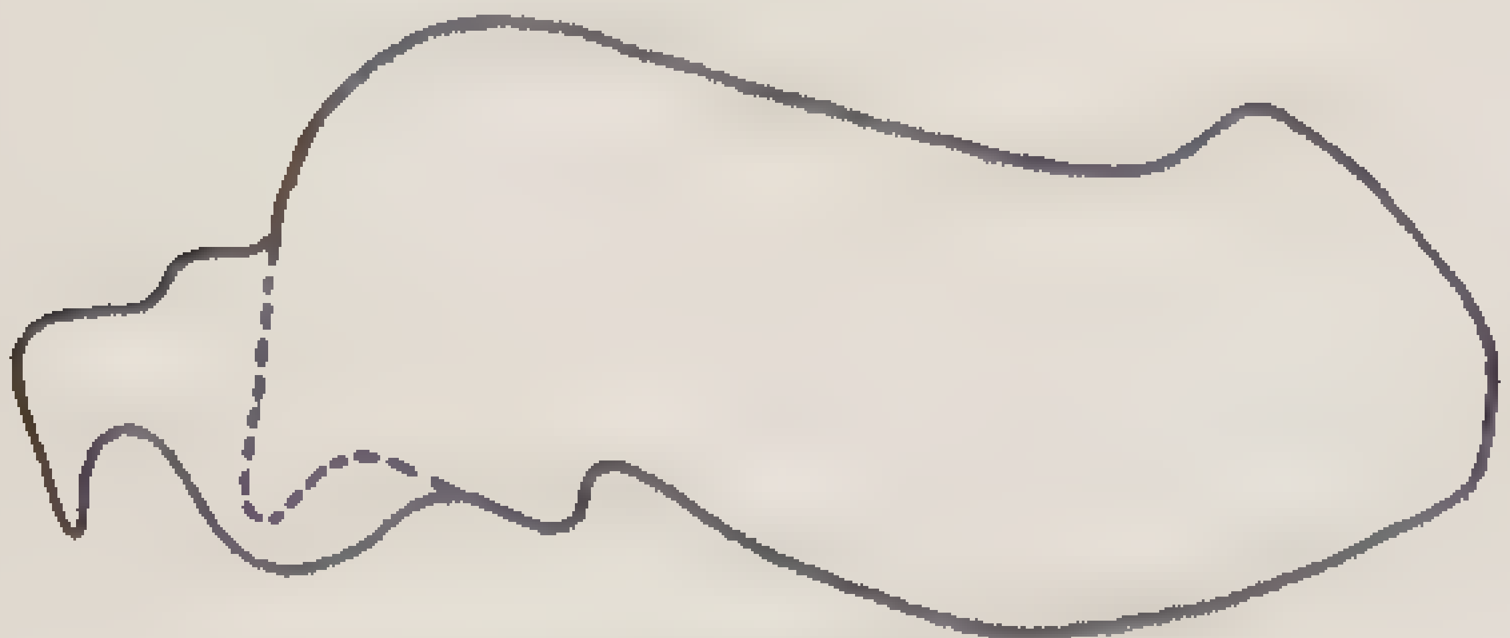
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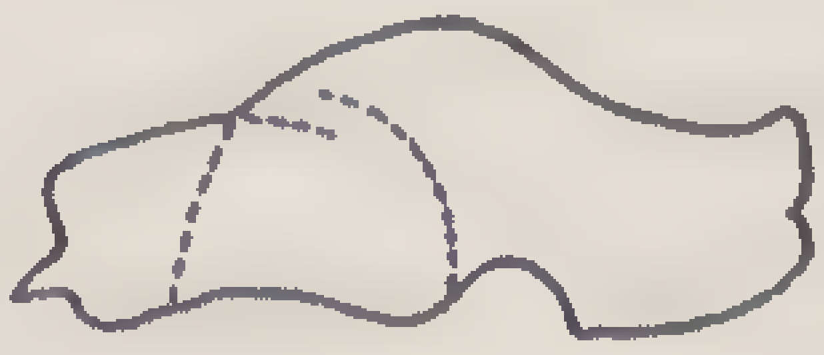
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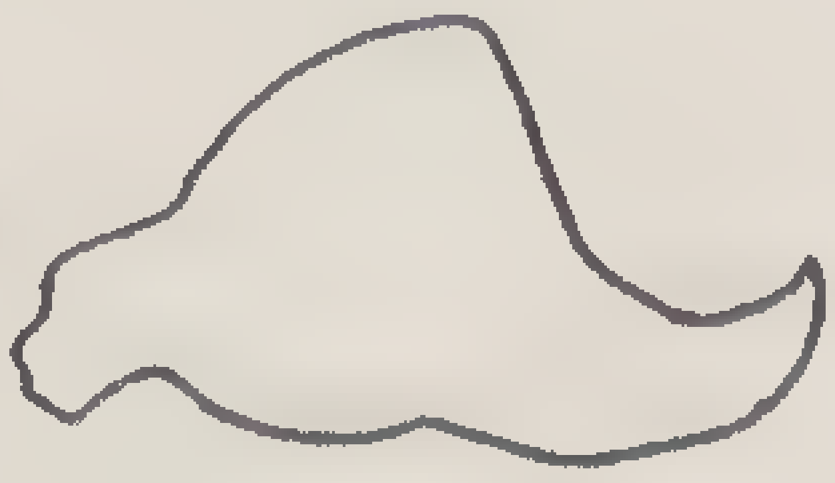
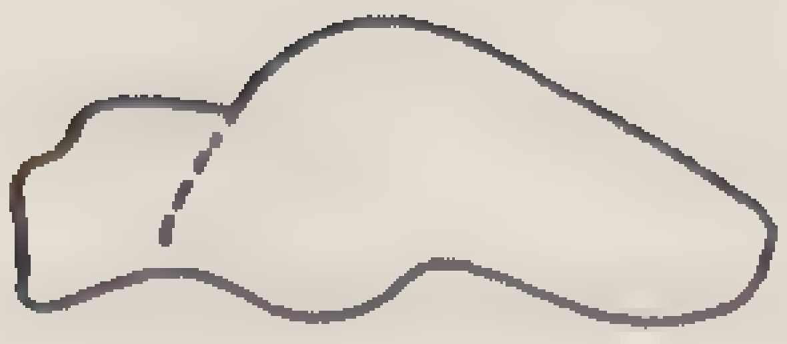

17 R. WILLIAMSI

PLATE VI

FIG. 1. *Rhagovelia choreutes* Hussey; right clasper, lateral view.
FIG. 2. *Rhagovelia formosa* Bacon; right clasper, lateral view.
FIG. 3. *Rhagovelia ignota* Drake and Harris; right clasper, lateral view.
FIG. 4. *Rhagovelia spinigera* Champion; right clasper, lateral view.
FIG. 5. *Rhagovelia acuminata* Bacon; right clasper, lateral view.
FIG. 6. *Rhagovelia armata* (Burmeister); right clasper, lateral view.
FIG. 7. *Rhagovelia collaris* (Burmeister); right clasper, lateral view.
FIG. 8. *Rhagovelia impensa* Bacon; right clasper, lateral view.
FIG. 9. *Rhagovelia planipes* Gould; right clasper, lateral view.
FIG. 10. *Rhagovelia scabra* Bacon; right clasper, lateral view.
FIG. 11. *Rhagovelia solida* Bacon; right clasper, lateral view.
FIG. 12. *Rhagovelia tayloriella* Kirkaldy; right clasper, lateral view.

PLATE VI

SPINIGERA GROUP



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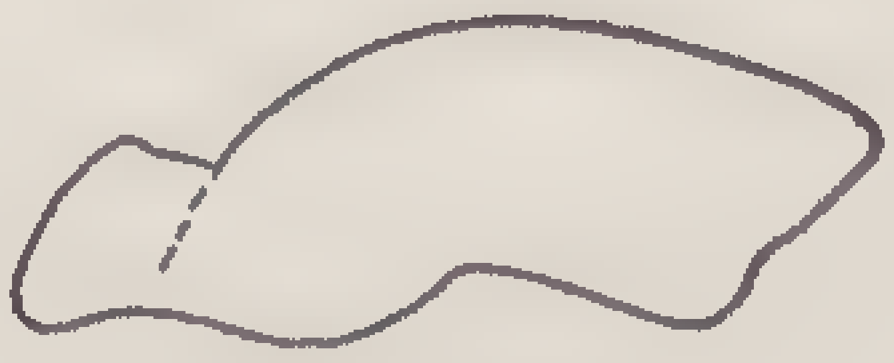

R. FORMOSA
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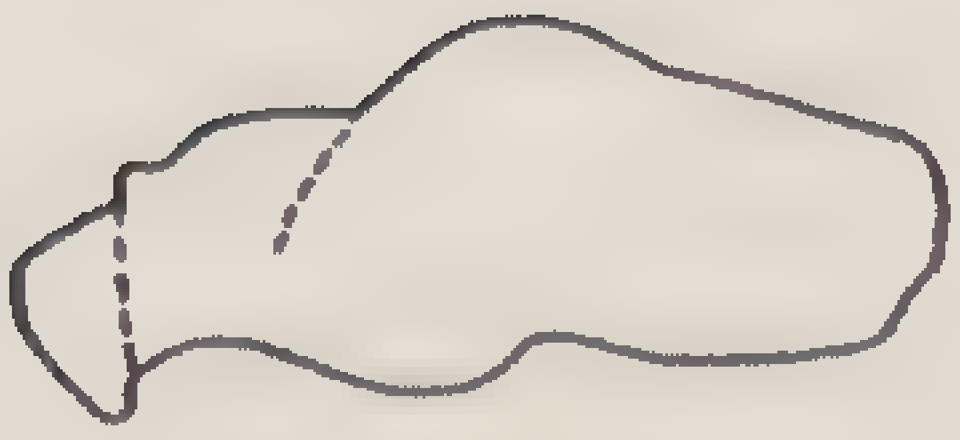

R. IGNOTA
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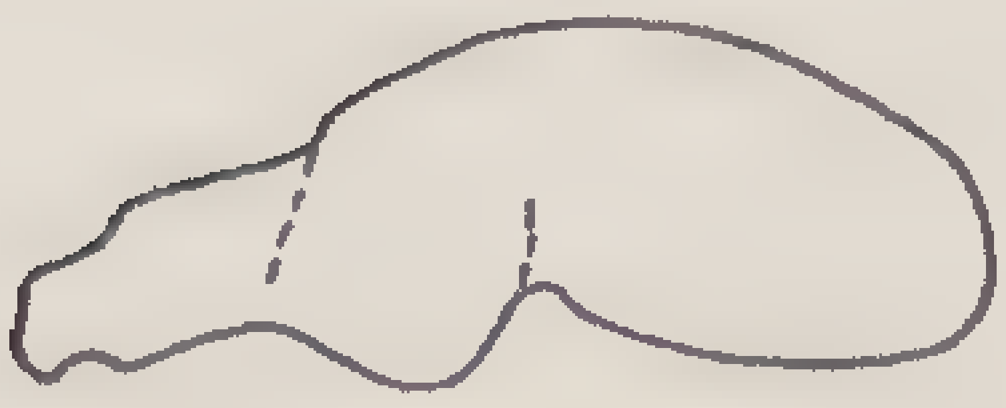

R. SPINIGERA
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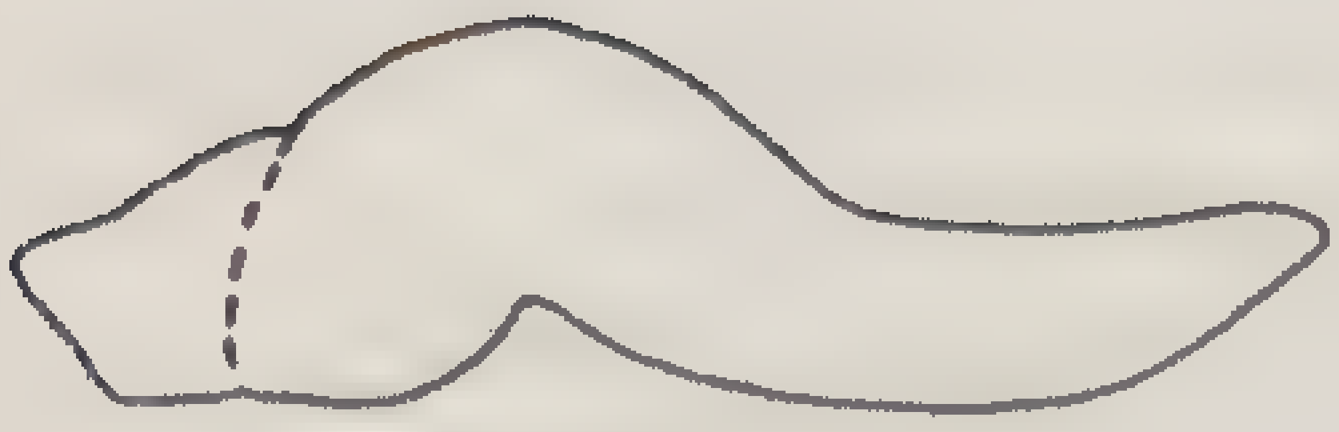
COLLARIS GROUP



R. ACUMINATA
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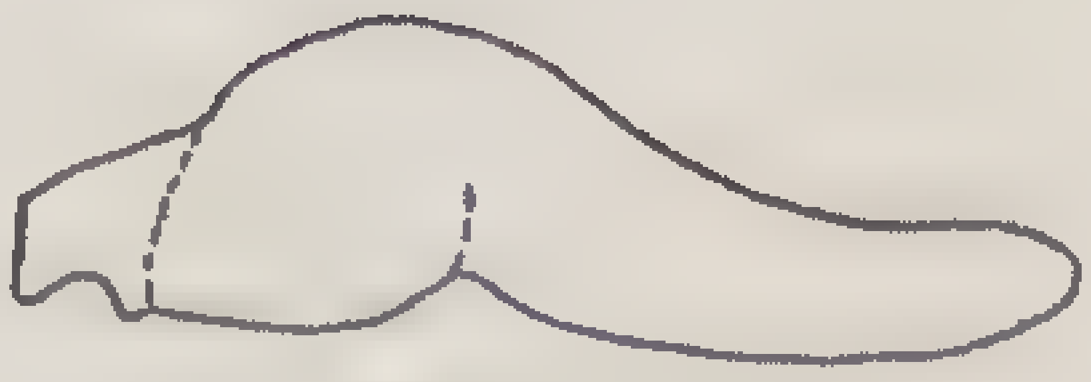

R. ARMATA
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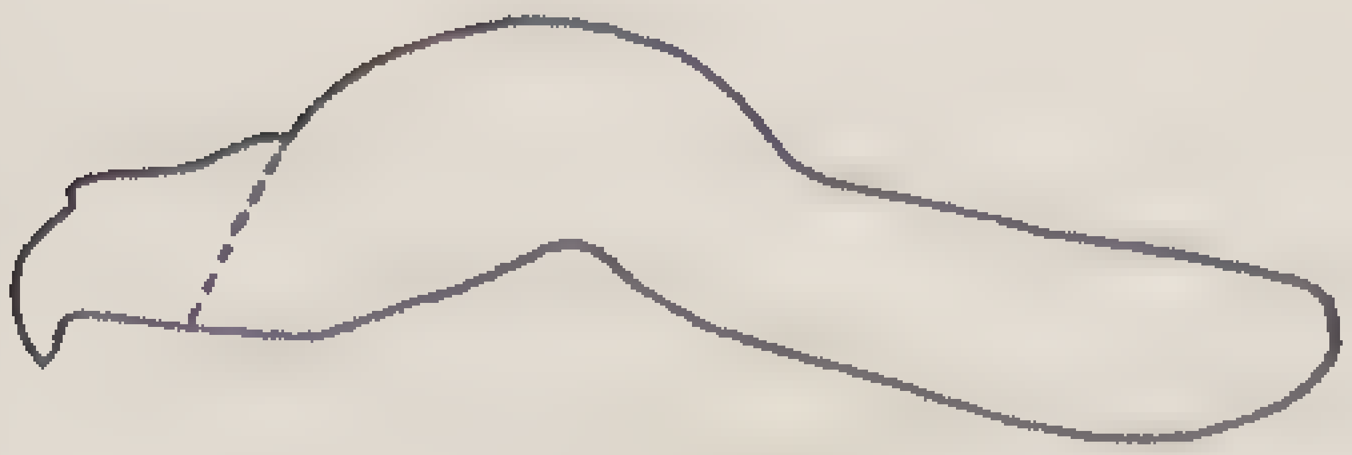

R. COLLARIS
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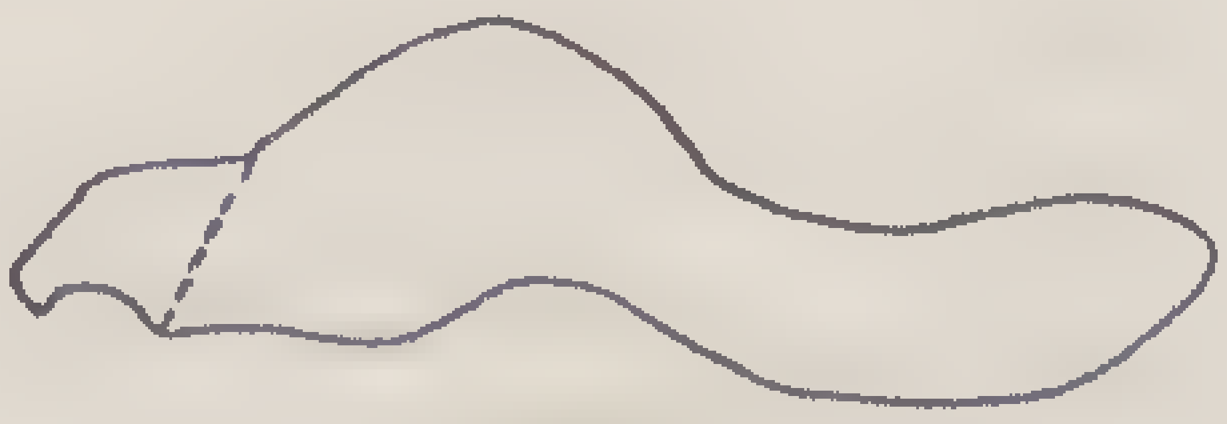

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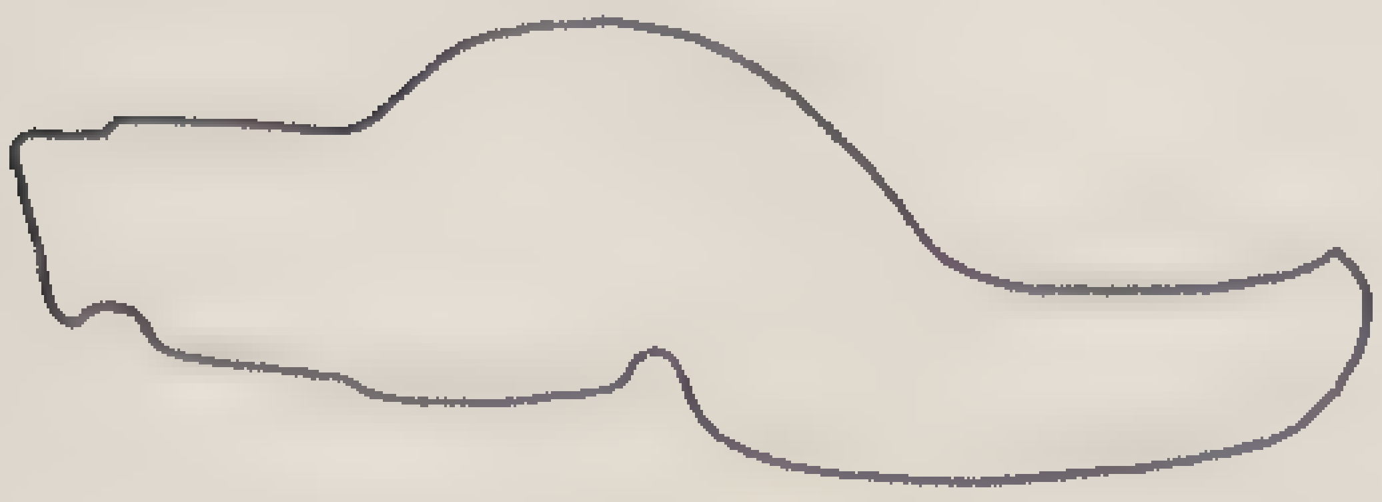

R. PLANIPES
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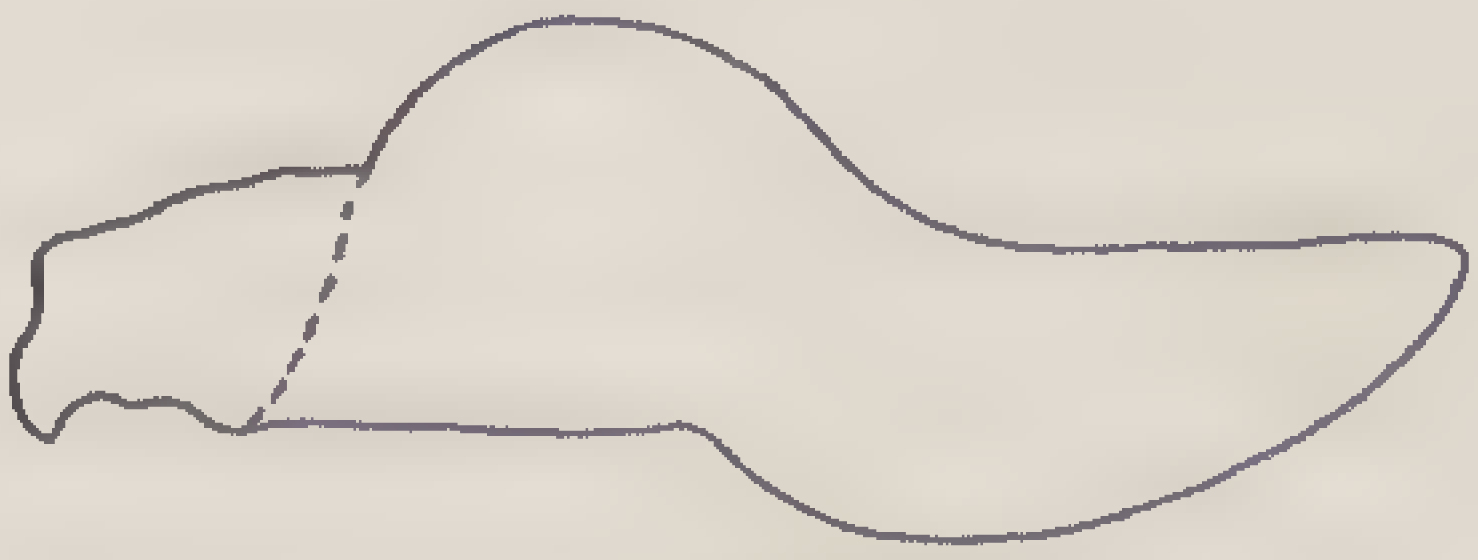

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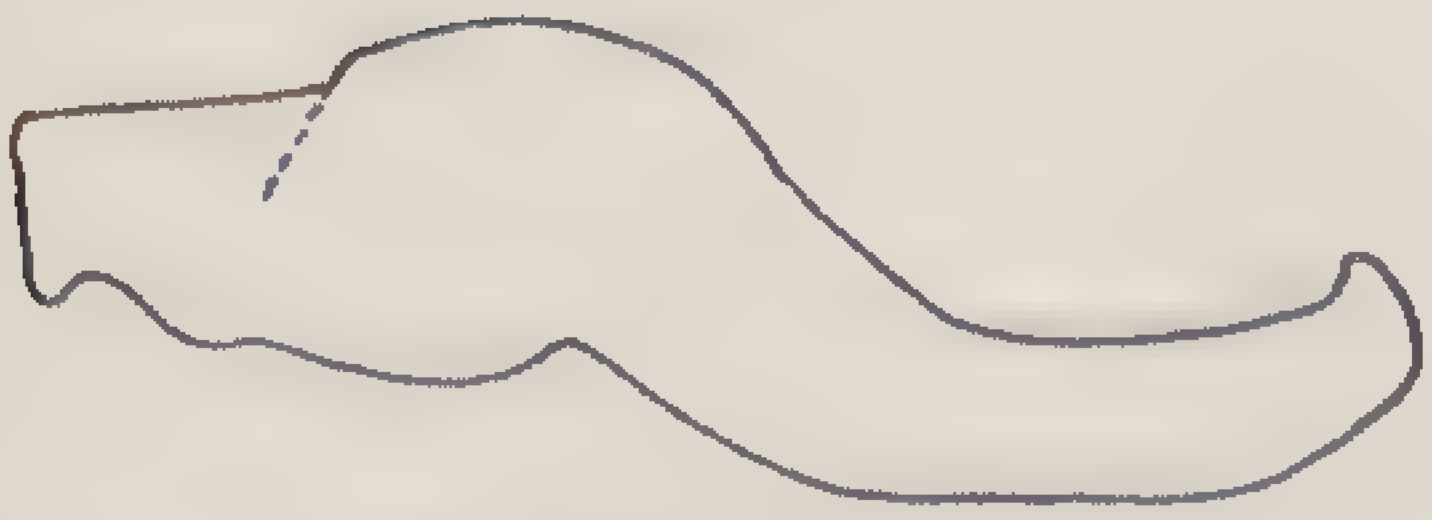

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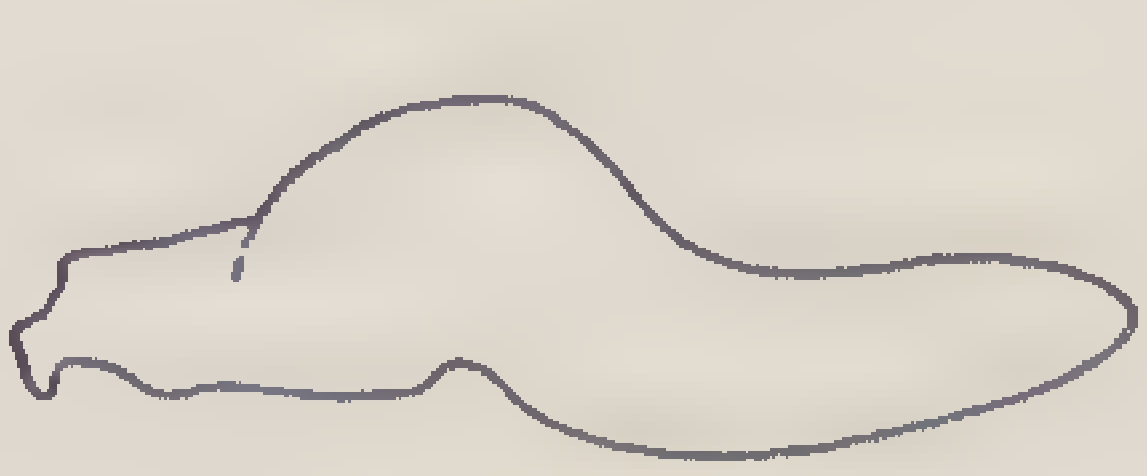


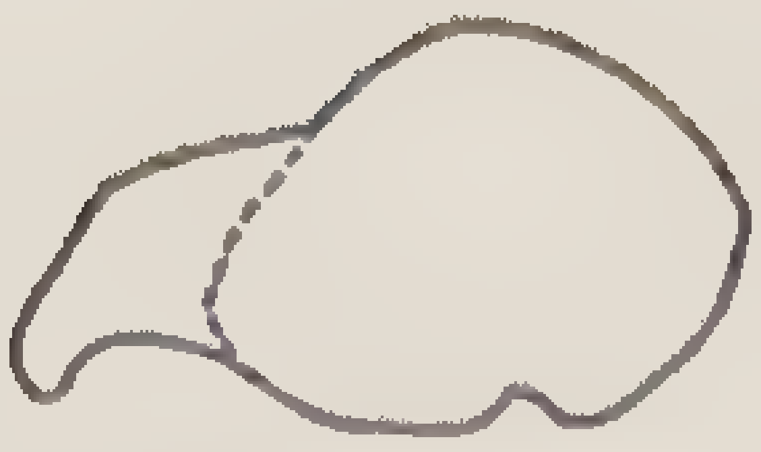
R. TAYLORIELLA
12

PLATE VII

FIG. 1. *Rhagovelia ainsliei* Drake and Harris; right clasper, lateral view.
FIG. 2. *Rhagovelia becki* Drake and Harris; right clasper, lateral view.
FIG. 3. *Rhagovelia gracilis* Bacon; right clasper, lateral view.
FIG. 4. *Rhagovelia distincta* Champion; right clasper, lateral view.
FIG. 5. *Rhagovelia knighti* Drake and Harris; right clasper, lateral view.
FIG. 6. *Rhagovelia obesa* Uhler; right clasper, lateral view.
FIG. 7. *Rhagovelia oriander* Parshley; right clasper, lateral view.
FIG. 8. *Rhagovelia rivale* Bueno; right clasper, lateral view.
FIG. 9. *Rhagovelia hirtipes* Drake and Harris; right clasper, lateral view.

PLATE VII

AINSLIEI GROUP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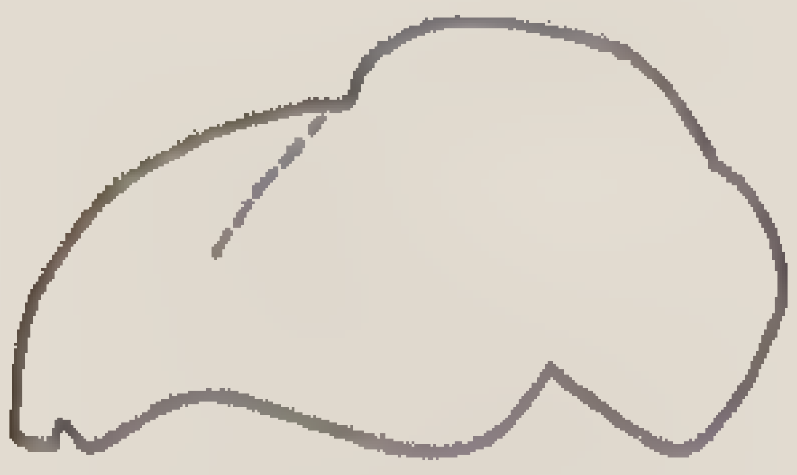
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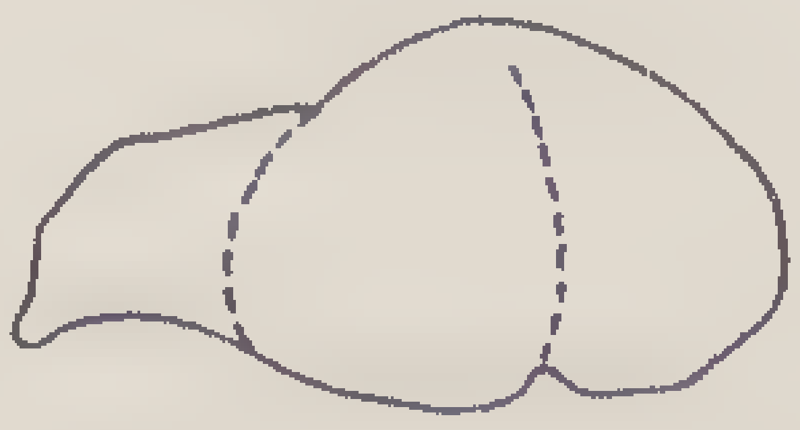
R. GRACILIS

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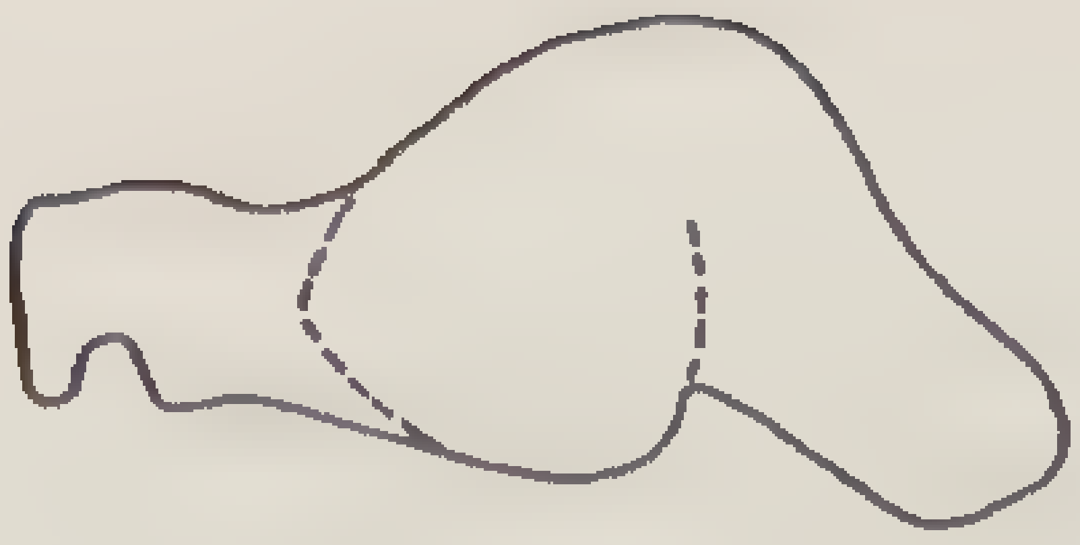
OBESA GROUP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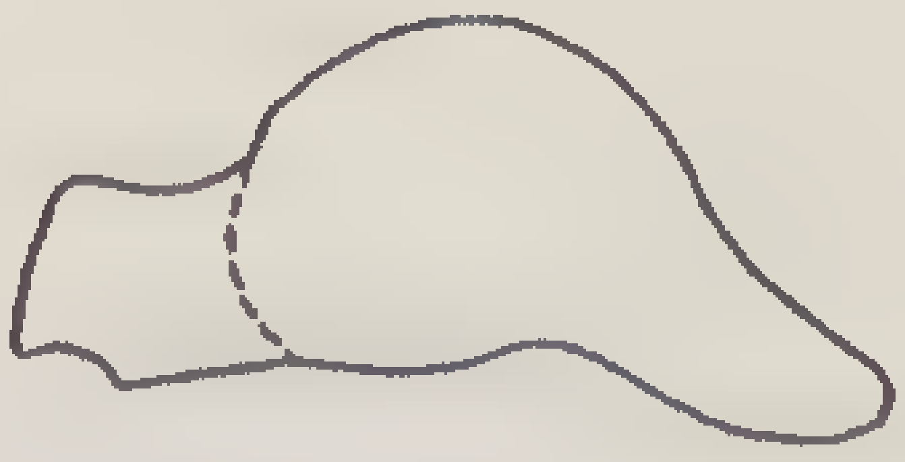
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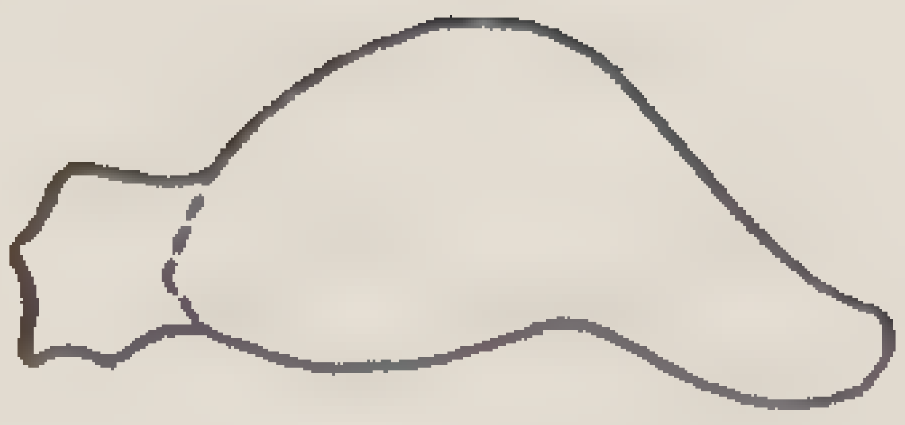
R. OBESA

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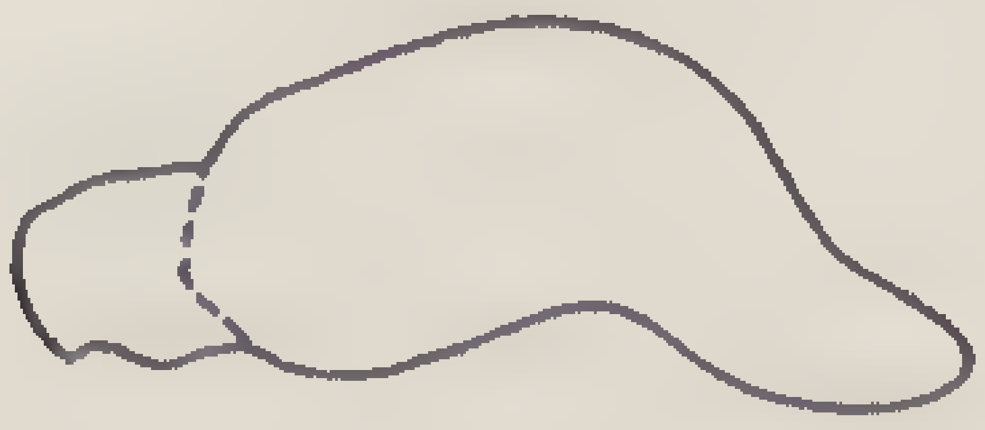
R ORIANDER

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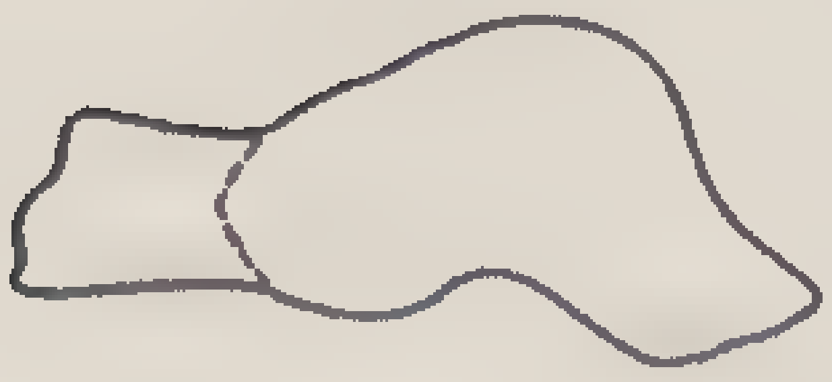
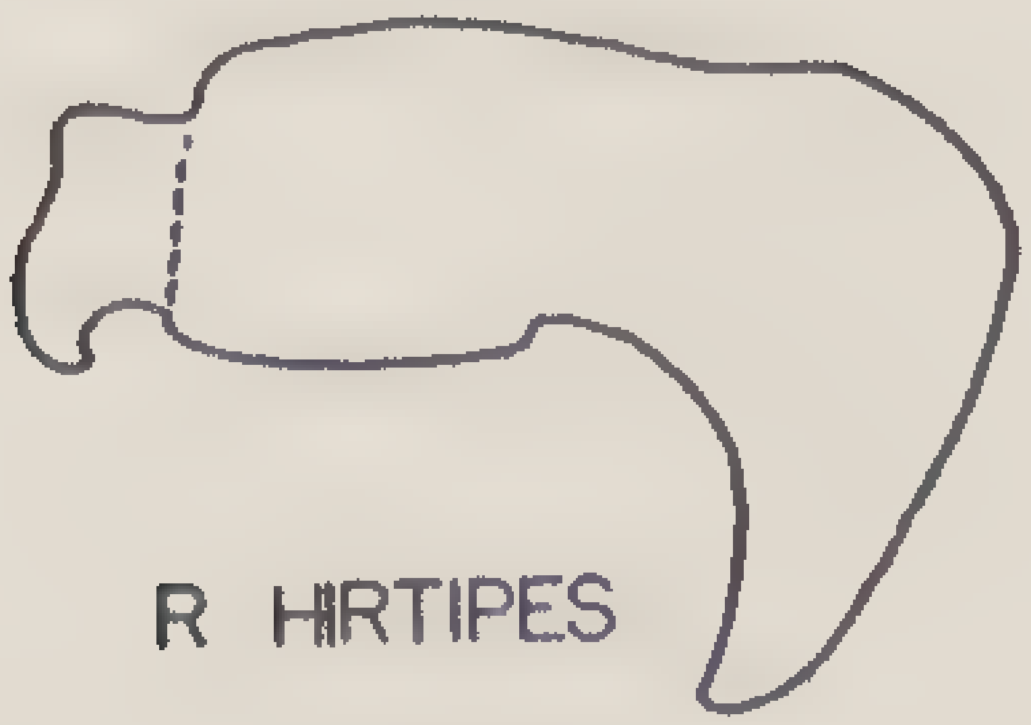

R RIVALE

8

HIRTIPES GROUP


R HIRTIPES

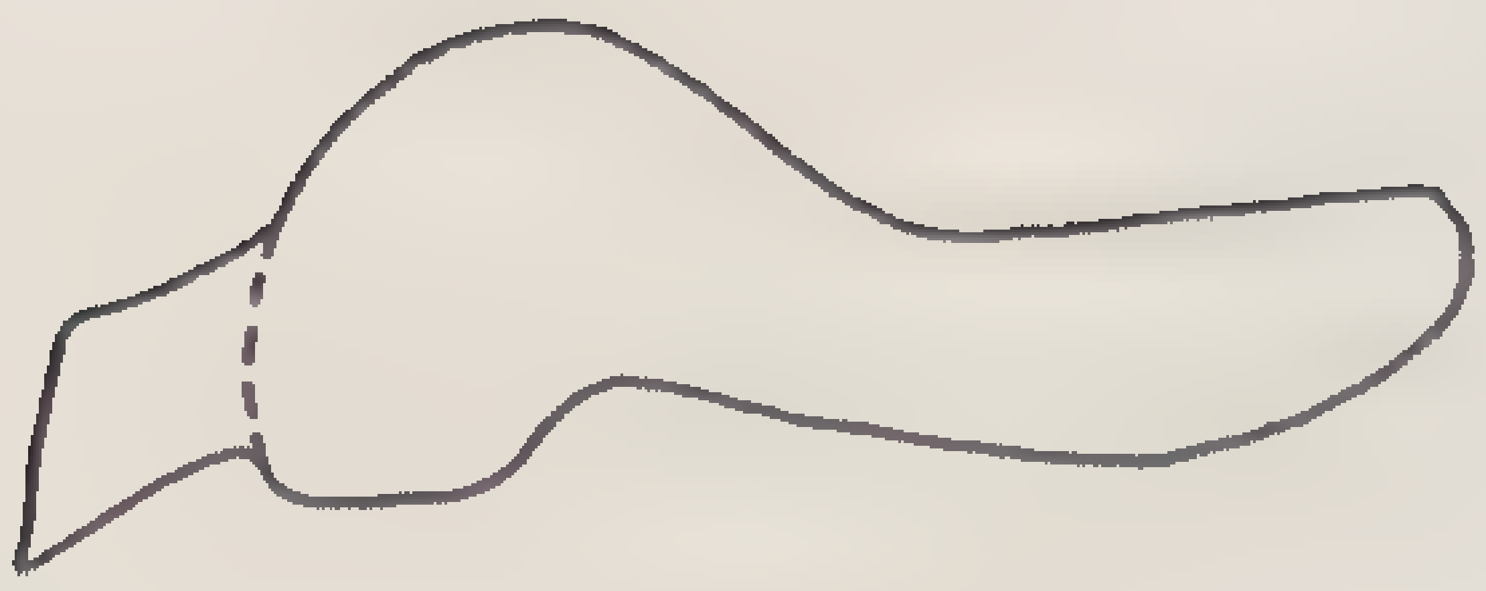
9

PLATE VIII

FIG. 1. *Rhagovelia citata* Drake; right clasper, lateral view.
FIG. 2. *Rhagovelia costalimai* Drake; right clasper, lateral view.
FIG. 3. *Rhagovelia mira* Drake and Harris; right clasper, lateral view.
FIG. 4. *Rhagovelia torreyana* Drake and Hussey; right clasper, lateral view.

PLATE VIII

ADDENDA



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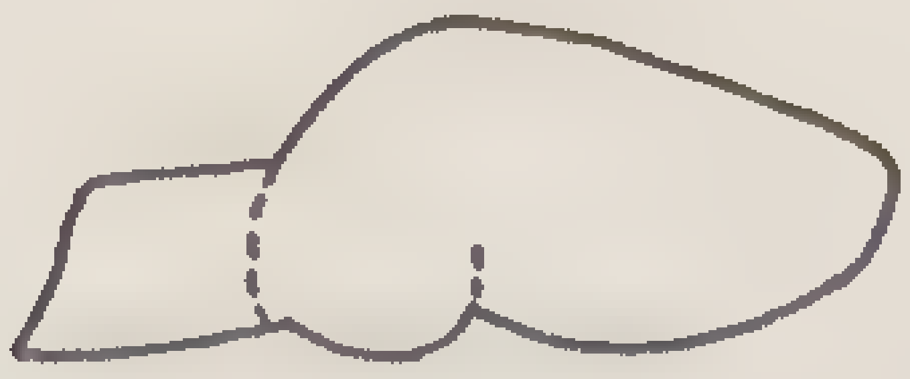

R. COSTALIMAI

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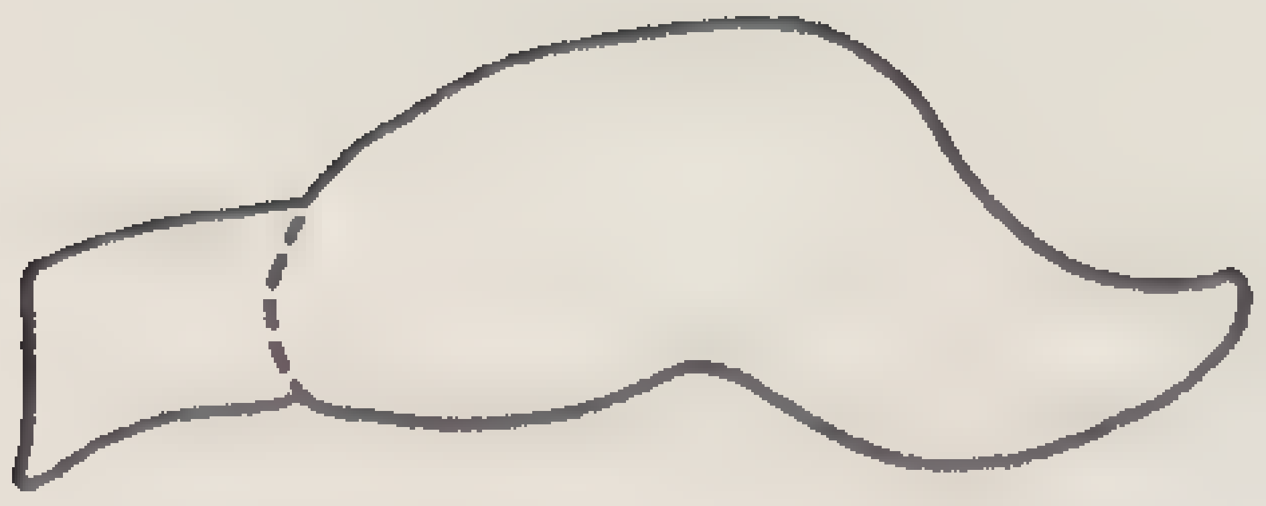

R. MIRA

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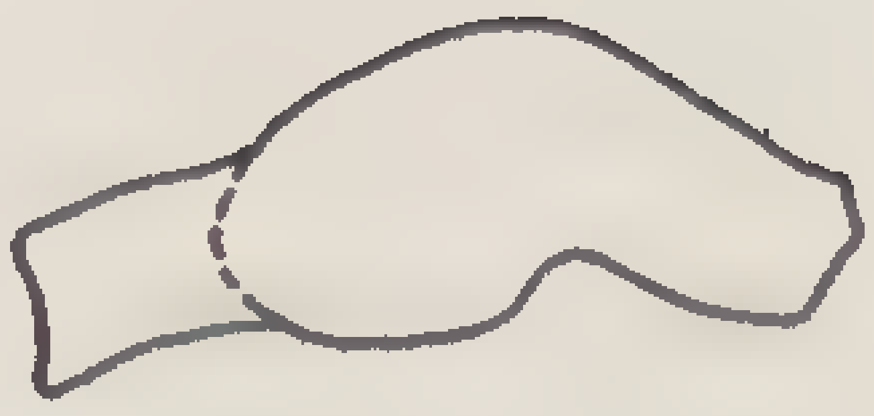

R. TORREYANA

4

THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN

VOL. XXXVIII, PT. I] DECEMBER 20, 1956 [No. 11

A Supplementary Taxonomic Study of the Genus *Rhagovelia* (Hemiptera, Veliidae) of the Western Hemisphere. A Deductive Method[1]

BY

RYUICHI MATSUDA
Department of Entomology, University of Kansas

ABSTRACT: This paper is intended to supplement Bacon's "A taxonomic study of the genus *Rhagovelia* (Veliidae, Hemiptera) of the Western Hemisphere."

Various taxonomic characters especially in winged forms are described and discussed. It is found that the genus *Rhagovelia* should be subdivided into three subgenera on the basis of three correlated characteristics, namely the wing venation, the pronotum in wingless forms, and the longitudinal carinae in dorsal abdominal segments in winged forms.

Descriptions of two subgenera, *Rhagovelia s. str.* and *Neorhagovelia*, are given. Also a few additional characters which this study has revealed are discussed from the viewpoint of phylogeny.

INTRODUCTION

As a supplement to Bacon's paper, "A taxonomic study of the genus *Rhagovelia* (Hemiptera, Veliidae) of the Western Hemisphere,"[2] the present study was undertaken to expand Bacon's work referring especially to winged forms of this genus, which have hitherto been more or less neglected by workers with this group of insects.

The problem with which the writer is primarily concerned in this study is, therefore, to determine the taxonomic value of the winged forms in this genus. This involves the study of a peculiar structure that occurs on the basal dorsal abdominal segments beneath the hemelytra in many families of Hemiptera-Heteroptera.

The taxonomic significance of this structure was suggested by the writer[3] who indicated that each particular pattern of fusion or modification in the first and second abdominal tergites and the resulting structures occur (1) at the subgeneric or generic level, or (2) in more than one genus within a tribe or subfamily, (3) in more or less constant form within a tribe or subfamily.

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[1] Contribution No. 921 from the Department of Entomology of the University of Kansas.

[2] Bacon, J. (1956), Univ. Kansas Sci. Bull., vol. 38, pp. 695-913.

The writer's first step was to investigate the structure in question. It soon became evident in the course of the study that there occur three distinct forms of the structure which have been shown to be represented by paired carinae in this genus. This indicates that there should exist three distinct groups within the genus if the first category of the hypothesis introduced above holds true. The next step taken was to correlate these three distinct types of carinae with other structures in other parts of the body in series of species in both winged and wingless forms for the test of the first category of the hypothesis. Forewing venation, pronotum in winged form, proportional length between dorsal abdominal segments in both winged and wingless forms, etc., were observed and described for each species for this purpose. The relative lengths of femur, tibia, and tarsal segments in intermediate and hind legs given by Bacon in his descriptions were also freely analyzed to find significant correlations.

Forty-five out of seventy-three species, *i. e.,* over sixty percent of species treated by Bacon, were available for the study of winged forms. This number of species will probably be large enough so that a significant conclusion can be drawn with a fair degree of certainty.

ACKNOWLEDGMENTS

The writer is grateful to Professor H. B. Hungerford for his kind guidance, to Professor R. E. Beer and Professor A. R. Barr for their constructive criticism.

MORPHOLOGY AND DESCRIPTIVE TECHNIQUE

The morphology of the family Veliidae was studied by Spooner (1938) on the head of *Rhagovelia obesa,* by Larsén (1945) on the thorax of *Velia currens,* and by Singh-Pruthi (1924) on the genital segments of *Velia currens.*

In the following report a rather simple morphological treatment of winged forms of the genus *Rhagovelia* is given together with the descriptive technique associated with the present study.

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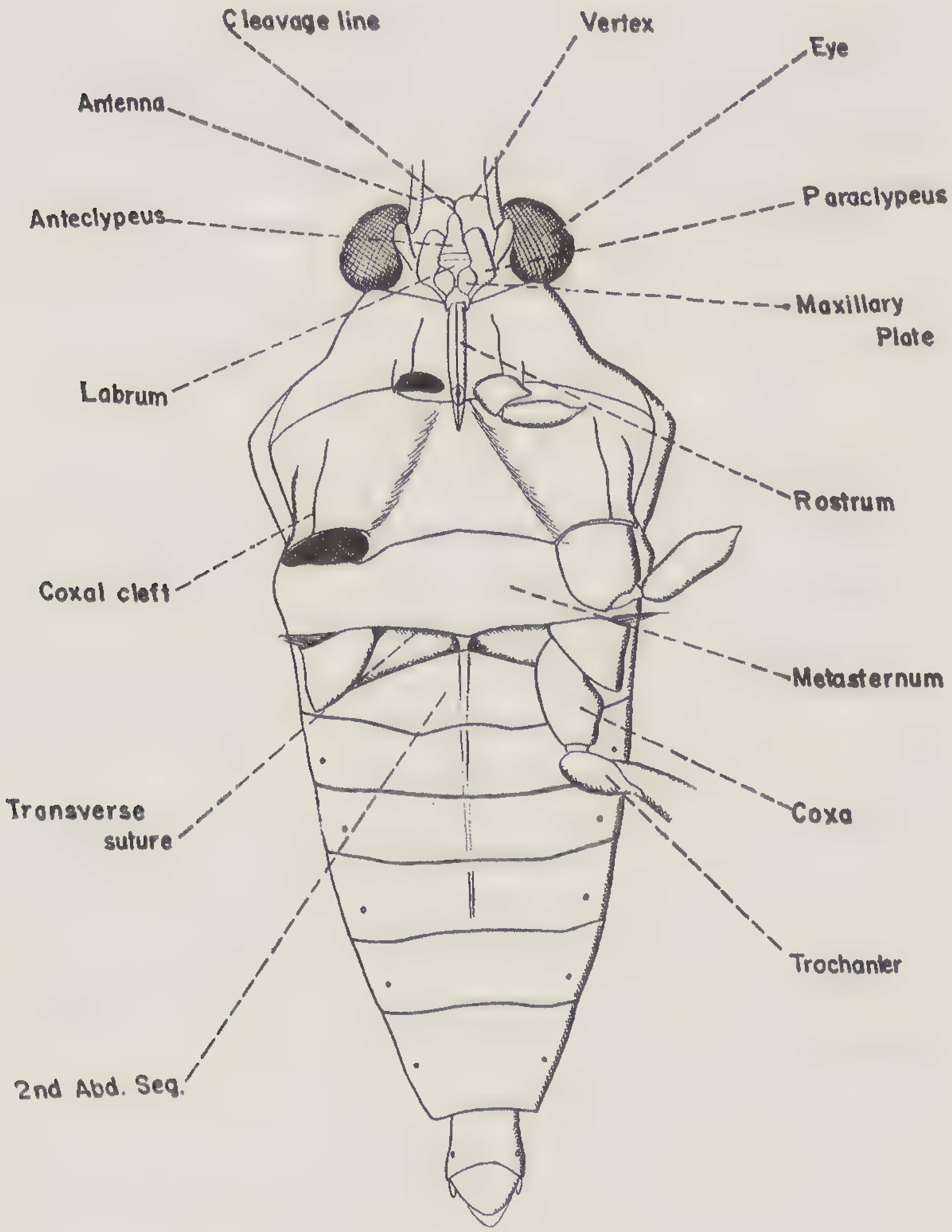
[3] Matsuda, R. (1955), The morphological and taxonomic significance of the basal dorsal abdominal segments in Hemiptera-Heteroptera. Pan-Pac. Ent. 31, 2 pp. 73-74.

THE HEAD (Pl. 1)

The compound eyes are large, usually as wide as the vertex at the posterior margin. The cleavage line begins at the posterior margin of the vertex and extends down to the anteclypeus without forming a typical Y-shaped divergence anteriorly. The labrum is a small plate located anterior to the anteclypeus and with a slender median projection, apically more or less enclosed by the bucculae



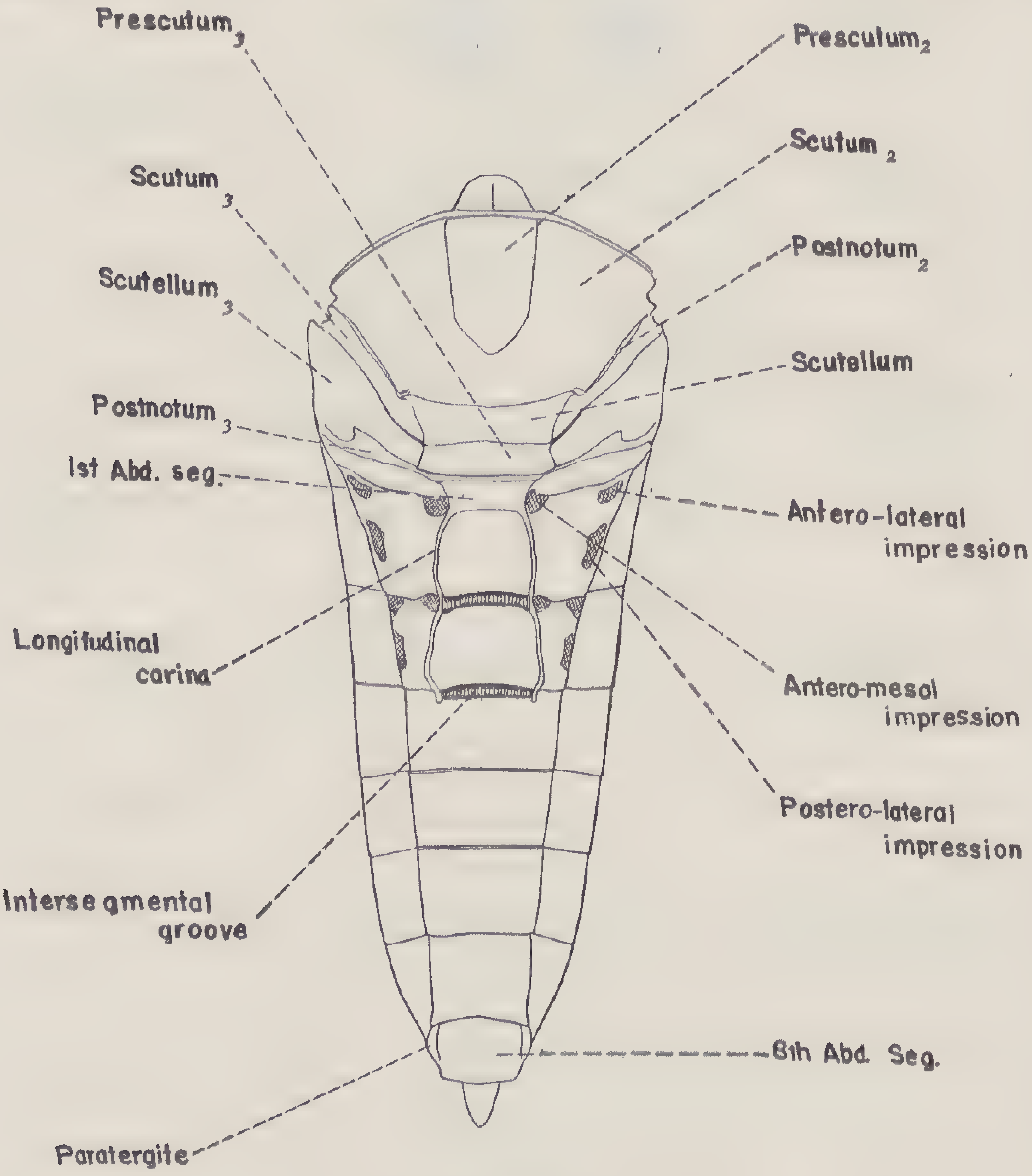
1. R.(R.) insularis

PLATE 1. *Rhagovelia (Rhagovelia) insularis* Champion. Ventral view.

(maxillary plate). The paraclypeus of Spooner (1938) lies laterad to the anteclypeus. The gena is the area between the lateral margin of the paraclypeus and the eyes. The rostrum is four-segmented with the second segment the longest. The antenna is four-segmented with a conspicuous protuberance at base between the lateral margin of the paraclypeal plate and the compound eyes. The ocellus is absent in this genus.

THE THORAX

The prothorax (Pl. 1): The pronotum is well developed posteriorly, and usually extends back to the first or second abdominal segment. In females of some species groups of this genus the pronotum develops into a long and narrow process. The pronotum, the pro-



2 ,R.(R.) insularis

PLATE 2. *Rhagovelia* (*Rhagovelia*) *insularis* Champion. Dorsal view.

pleurum and the presternum are indistinguishably fused. The sternal region is depressed longitudinally to accommodate the rostrum. The coxal cleft runs anteriorly.

The mesothorax (Pls. 1, 2): The mesonotum is completely hidden beneath the pronotum. The prescutum is the median elongate subpentagonal region defined posteriorly and laterally by the scutum on which the forewings are articulated. The scutellum is located posterior to the scutum as a transverse sclerite; it does not develop posteriorly to be exposed between the wings as in most families of Heteroptera. The postnotum is a very narrow sclerite running along the posterolateral margin of the scutum. The pleurum and the sternum are indistinguishably fused. The sternal region is slightly depressed. The coxal cleft goes anteriorly beyond the middle of the ventral surface of the mesothorax. A paired oblique row of long and white pubescence is disposed from near the middle of the posterior margin of the prosternum to the inner posterior angle of the acetabula. This oblique row of pubescence is lacking in marine forms.

The metathorax (Pls. 1, 2): The usual four component parts of the notum in the metathorax are clearly recognizable. The prescutum is a transverse plate directly behind the posterior margin of the mesothoracic scutellum. The scutum is an oblique, narrow plate along the mesothoracic postnotum and the hind wings are articulated on this plate. The scutellum is clearly defined from the scutum by an oblique suture and occupies a lateral, rather large subtriangular area of the metanotum. The postnotum is here interpreted as being represented by the plate behind the scutellum defined anteriorly by a sinuate suture. The usual scent gland-opening is sometimes clearly visible behind the posterior margin of the mesopleurum. The pleurum and the sternum are indistinguishably fused. Another characteristic scent gland in the Veliidae on the lateral region of the acetabula is provided with a tuft of erected hairs. Each scent gland opening is connected by a transverse suture across the sternum. This suture is here termed "the ventral transverse suture" for descriptive purpose. There is no coxal cleft in the metathorax. According to Taylor (1918) the pleural suture is frequently absent in Heteroptera. How far the coxal cleft is associated with the pleural suture in this genus was not investigated, but the indication is that the coxal clefts in the pro- and mesothorax do not seem to contain a part of the pleural suture judging from the course of the cleft.

THE WING (Pl. 3)

The wing base was not studied.

The forewing: The forewing is not well differentiated into distinct corium, clavus, and membrane as in other families of Heteroptera. The uppermost vein is apparently the subcosta. The next vein is a union of the radial, median and cubital veins basally. The lower vein is anal. In one major group of the genus *Rhagovelia* two closed apical cells are formed in the distal half. The apical cells in the other major group of the genus are more or less obliterated or small when present.

The hind wing: The more generalized wing venation is seen in the hind wing. The second vein is apparently R + M basally instead of R + M + Cu in the forewing. Cu is basally fused with anal veins along the anal fold. There is no considerable difference in hind wing venation between the two major groups of the genus *Rhagovelia.*

THE ABDOMEN

The first dorsal abdominal segment is reduced but still retained as a distinct plate. This segment is always with a median elevated area. The second and third dorsal abdominal segments and also occasionally the fourth segment are provided with paired longitudinal carinae arising from the lateral part of the median elevated area of the first segment. The second and third segments are always provided with three more or less distinct laevigate impressions on the outer sides of the longitudinal carinae; the one immediately on outer sides of the carinae is called "the anteromesal impression"; the other two impressions along the inner margin of the connexivum are called "the anterolateral and posterorlateral impression" respectively in description. The posterior margin of each second and third segment between the posterior ends of longitudinal carinae is more or less lengthened and deeply defined obscuring its original posterior margin and the anterior margin of the succeeding segment. This region is, therefore, called "the intersegmental groove" in description, and the numerical value of each segment refers to the length from the middle of anterior margin of the intersegmental groove to the same of the intersegmental groove of the succeeding segments. On the eighth segment there is a laterally partitioned area; this is especially clearly seen in the winged female and this plate is supposedly a fragmented part of the tergum, and called the paratergum in taxonomy. The first ventral abdominal segment is completely lost. The second segment contributes towards the formation of the ventral wall of the metathoracic coxal cavity. The third to seventh segments are occasionally armed with a median longitudinal elevation. The description of the genital segments is left for a study planned in the near future by the writer.

GROUP CHARACTERISTICS OF THE ANGUSTIPES GROUP

The winged forms of following twelve species out of twenty-three species treated by Bacon were available for study:

Rh. angustipes Uhler
Rh. bisignata Drake and Harris
Rh. calopa Drake and Harris
Rh. fontanalis Bacon
Rh. imitatrix Bacon
Rh. longipes Gould
Rh. janeira Drake
Rh. paulana Drake
Rh. spinosa Gould
Rh. tantilla Drake and Harris
Rh. tenuipes Champion
Rh. versuta Bacon

In this species group the longitudinal carinae on the basal dorsal abdominal segments occur always on the second segment usually as distinct and well-developed carinae reaching to the posterior margin. The carinae also often occur on the third segment as less distinct ones which are subject to individual variation as seen in *Rh. janeira, Rh. fontanalis, Rh. spinosa, Rh. versuta, Rh. tenuipes, Rh. longipes, Rh. calopa,* and *Rh. bisignata.*

Forewing venation is subject to specific variation within the group which fits more or less three types shown in the accompanying text figures (Pl. 3). Small apical cells range from one to two in number, and these cells are often obliterated in some individuals within the species. The constant feature of the forewing venation in this species group is that the subcosta never develops further than the middle of anterior margin of the wing and the apical cell or cells are always formed within the proximal half of the wing.

The pronotum in winged forms is always bluntly rounded apically and without sexual difference.

Proportional length between sixth and seventh dorsal abdominal segments in winged males ranges from 32:60 in *Rh. janeira* to 40:58 in *Rh. fontanalis,* that in wingless males ranges from 22:42 in *Rh. spinosa* to 38:48 in *Rh. tantilla.* The proportional length of seventh and eighth dorsal abdominal segments in wingless females ranges from 46:35 in *Rh. paulana* to 43:51 in *Rh. tantilla,* that in wingless females ranges from 58:37 in *Rh. modesta* to 41:48 in *Rh. longipes.*

In the hind leg the femur is shorter than the tibia in the majority of species within the group (twenty out of twenty-two species measured). Only in *Rh. callida* and *Rh. tenuipes* the femur is definitely longer than the tibia.

In the intermediate leg the tibia is less than twice as long as the second tarsal segment (sixteen out of twenty-two species). The proportional length of the second and third segments seems to give group characters. In six species the second tarsal segment is longer than the third tarsal segment (*Rh. bisignata, Rh. callida, Rh. imitatrix, Rh. longipes, Rh. modesta, Rh. plumbea*); in three species (*Rh. plana, Rh. salina, Rh. tenuipes*) the second tarsal segment is longer than the third segment in males, equal or slightly shorter in females; in the rest of species in this group the second segment is shorter than the third segment which is true of all species in this genus except for four species that will be noted later.

In wingless forms the pronotum is shorter than the length of eye, with the posterior margin straight, sinuate or concave. The dorsum of the abdomen of the wingless female tapers rather evenly to the apex.

In spite of slight deviation in some characters in some species this group seems to be a well-defined natural group.

Rhagovelia angustipes Uhler

(Pl. 3, fig. 6; pl. 4, figs. 8a, b)

1894. *Rhagovelia angustipes* Uhler, Proc. Zool. Soc. London, p. 125.

Winged female: Pronotum reaching the basal region of second dorsal abdominal segment. Forewing fuscous, with two well-defined small apical cells. Proportional length of dorsal abdominal segments (second to eighth):: 33: 33: 33: 39: 42: 47: 42. Second dorsal abdominal segment with longitudinal carinae rather narrow, reaching to posterior margin of the same segment; usual three laevigate impressions shallow, clearly separated from each other; intersegmental groove rather shallow. Third dorsal abdominal segment without longitudinal carina, anteromesal laevigate impression transverse, anterolateral and posterolateral impressions are contiguous. Connexivum rather strongly reflexed. Visible first connexival segment short, visible third and fourth connexival segments transverse. Seventh dorsal abdominal segment transverse, posterior margin feebly sinuate, seventh connexival segment with lateral margin straight. Eighth segment with posterolateral margin feebly rounded, posterior margin substraight.

Wingless female: Posterior margin of pronotum concave, feebly produced posteriorly at middle, posterior margin of mesonotum obliterated. Posterior margin of metanotum broadly sinuate. Proportional length of dorsal abdominal segments (first to eighth)::

31: 26: 27: 30: 35: 40: 48: 52. Posterior and anterior margins of first dorsal abdominal segment broadly rounded. Metasternum behind transverse suture shorter at middle.

Rhagovelia bisignata Bacon

(Pl. 3, fig. 5; pl. 4, figs. 9a, b)

1948. *Rhagovelia bisignata* Bacon, Jour. Kansas Ent. Soc., vol. 21, no. 3, p. 71.

Winged female: Pronotum reaching the base of first dorsal abdominal segment. Forewings yellowish brown, veins dark fuscous, with one lower apical cell. Proportional length of dorsal abdominal segments (second to eighth):: 39: 37: 40: 39: 41: 45: 42. First dorsal abdominal segment with posterior margin obliterated in the middle. Second segment with longitudinal carinae roundly produced laterally in the middle, usual three laevigate impressions shallow and small, clearly separated from each other; intersegmental groove between second and third segments is represented by a transverse row of shallow obscure impressions. Third dorsal abdominal segment with longitudinal carinae obliterated, sometimes invisible; anteromesal impression obliterated, anterolateral and posterolateral impressions continuous and well marked; intersegmental groove between third and fourth segments is represented by a transverse row of shallow impressions. Seventh dorsal abdominal segment transverse, posterior margin rounded; seventh connexival segment with lateral margin slightly sinuate. Eighth segment with posterior margin substraight, rounded laterally.

Wingless female: Proportional length of dorsal abdominal segments (first to eighth):: 22: 35: 38: 40: 38: 41: 52: 50. Connexivum more strongly reflexed than in male, apical end almost reaching to the middle of eighth segment.

Wingless male: Proportional length of dorsal abdominal segments (first to eighth):: 18: 22: 22: 23: 23: 28: 50: 40 (holotype). Posterior margin of pronotum shallowly concave. Mesonotum long, posterior margin almost reaching to anterior margin of first dorsal abdominal segment. Metasternum behind transverse suture relatively long, shorter at middle.

Rhagovelia callida Drake and Harris

1935. *Rhagovelia callida* Drake and Harris, Proc. Biol. Soc. Washington, vol. 48, p. 34.

Wingless male: Posterior margin of pronotum roundly concave, feebly produced posteriorly in the middle. Posterior margin of mesonotum obscurely bisinuate. Proportional length of dorsal abdominal segments (first to seventh):: 23: 26: 26: 23: 24: 33: 60. Anterior margin of first dorsal abdominal segment feebly sinuate. Eighth segment dilated apically. Metasternum behind transverse suture shorter at middle, inclined posteriorly.

Wingless female: Proportional length of dorsal abdominal segments (first to eighth):: 30: 33: 35: 38: 38: 46: 58: 50. Connexivum subvertically reflexed.

Rhagovelia calopa Drake and Harris

(Pl. 4, figs. 10a, b)

1927. *Rhagovelia calopa* Drake and Harris, Proc. Biol. Soc. Washington, vol. 40, p. 135.

Winged male: Pronotum reaching the basal region of second dorsal abdominal segment. Forewings fuscous, with two closed apical cells. Proportional length of dorsal abdominal segments (second to eighth):: 32: 25: 30: 32: 36: 60: 50. First dorsal abdominal segment with median elevated area straight on its posterior margin. Second segment with longitudinal carinae slightly divergent posteriorly; three laevigate impressions are connected by well-sculptured depressions along posterior margin of first segment and inner margin of second connexival segment; intersegmental groove between second and third segments finely longitudinally rugose. Third segment with longitudinal carinae finer than those on the second segment, subject to individual variation in length, obliterated behind middle in one male, almost reaching to posterior margin of third segment in one female examined; three impressions on the segment are connected in the same way as in second segment; intersegmental groove between third and fourth segments obscurely longitudinally rugulose.

Wingless male: Pronotum with posterior margin substraight. Mesonotum with posterior margin well defined and straight. Proportional length of dorsal abdominal segments (first to seventh):: 33: 33: 31: 31: 30: 35: 55. Posterior margin of first dorsal abdominal segment bisinuate, anterior margin of the same segment feebly produced. Metasternum behind transverse suture shortened medially and inclined posteriorly.

Winged female: Proportional length of dorsal abdominal segments (first to eighth):: 20: 37: 33: 36: 40: 50: 52: 42. Connexivum horizontally spread laterally. Seventh segment a little wider than long, lateral margin subparallel; seventh connexival segment with lateral margin straight. Eighth segment a little shorter than seventh segment, posterolateral margin feebly sinuate, posterior margin substraight.

Wingless female: Proportional length of dorsal abdominal segments (first to eighth):: 30: 30: 31: 34: 34: 38: 48: 33. Metasternum behind transverse suture as in male.

Rhagovelia deminuta Bacon

1948. Rhagovelia deminuta Bacon, Jour. Kansas Ent. Soc., vol. 21, no. 3, p. 72.

Wingless male: Pronotum with posterior margin bisinuate on either side of the middle. Mesonotum with posterolateral margin feebly sinuate. Posterior margin of metanotum shallowly concave. Proportional length of dorsal abdominal segments (first to eighth):: 14: 22: 20: 19: 22: 23: 39: 39 (holotype). Metasternum behind transverse suture relatively long, slightly shortened medially.

Wingless female: Proportional length of dorsal abdominal segments (first to eighth):: 16: 23: 24: 23: 28: 32: 42: 40 (allotype). Connexivum more strongly reflexed than in male; the last three segments reflexed at a little more than ninety degrees. Metasternum behind transverse suture slightly shortened medially.

Rhagovelia evidis Bacon

1948. *Rhagovelia evidis* Bacon, Jour. Kansas Ent. Soc., vol. 21, no. 3, p. 73.

Wingless male: Posterior margin of pronotum broadly sinuate, posterolateral margin feebly sinuate, posterior margin well defined and feebly rounded. Proportional length of dorsal abdominal segments (first to eighth):: 23: 19: 19: 20: 20: 25: 38: 28 (holotype). Posterior margin of first dorsal abdominal segment broadly rounded. Metasternum behind transverse suture feebly shortened medially.

Wingless female: Proportional length of dorsal abdominal segments (first to eighth):: 31: 21: 23: 25: 28: 35: 42: 35.

Remarks: In the male of this species and in both sexes of *Rh. deminuta* the femur is equal in length to the tibia in the hind leg.

Rhagovelia fontanalis Bacon

(Pl. 4, figs. 11a, b)

1948. *Rhagovelia fontanalis* Bacon, Jour. Kansas Ent. Soc., vol. 21, no. 3, p. 74.

Winged male: Pronotum reaching to the basal region of second abdominal segment. Forewing fuscous, veins black, with two distinct apical cells. Proportional length of dorsal abdominal segments (first to seventh):: 9: 37: 33: 33: 36: 40: 58. First dorsal abdominal segment with posterior margin well-defined and roundly emarginated in the middle. Second segment with longitudinal carinae slightly roundly divergent posteriorly, reaching to posterior margin; anteromesal impression rather obliterated, anterolateral and posterolateral impressions clearly separated; intersegmental groove between second and third segments rather shallow. Third dorsal abdominal segment with longitudinal carinae subject to individual variation ranging from basal one third to almost reaching posterior margin of third segment; anteromesal impression obliterated, anterolateral and posterolateral impressions narrow and contiguous; intersegmental groove between third and fourth segments extends almost to inner posterior angle of third connexival segment. Metasternum behind transverse suture lengthened laterally.

Wingless male: Posterior margin of pronotum broadly concave. Posterior margin of mesonotum obliterated. Proportional length of dorsal abdominal segments (first to eighth):: 22: 30: 33: 33: 38: 43: 65: 45. Posterior margin of first to third dorsal abdominal segments distinctly rounded, posterior margin of eighth dorsal abdominal segment sinuate. Metasternum behind transverse suture shortened medially.

Winged female: Proportional length of dorsal abdominal segments (third to eighth):: 38: 38: 44: 47: 48: 43. Seventh dorsal abdominal segment slightly widened posteriorly, posterior margin sinuate; seventh connexival segment straightly narrowed apically, apex with a bundle of black and long hairs. Eighth segment with posterior margin rounded. Metasternum behind transverse suture lengthened laterally.

Wingless female: Proportional length of dorsal abdominal segments (first to seventh):: 33: 35: 39: 39: 45: 51: 45. Connexivum flattened out laterally.

Rhagovelia hambletoni Drake and Harris

1933. *Rhagovelia hambletoni* Drake and Harris, Proc. Biol. Soc. Washington, vol. 46, p. 48.

Wingless male: Pronotum with posterior margin broadly sinuate, feebly produced posteriorly in the middle. Mesonotum with posterior margin approaching to anterior margin of first dorsal abdominal segment. Proportional length of dorsal abdominal segments (first to eighth):: 18: 23: 23: 24: 24: 31: 58: 39. Seventh connexival segment not extending beyond posterior margin of seventh dorsal abdominal segment. Metasternum behind transverse suture subequal in length throughout, slightly lengthened near leg base.

Wingless female: Connexivum strongly reflexed and the ventral side well-exposed above. Proportional length of dorsal abdominal segments (first to eighth):: 20: 26: 30: 32: 35: 45: 53: 45 (paratype). Metasternum behind transverse suture as in male.

Rhagovelia imitatrix Bacon

(Pl. 5, figs. 12a, b)

1948. *Rhagovelia imitatrix* Bacon, Jour. Kansas Ent. Soc., vol. 21, no. 3, p. 76.

Winged female: Apex of pronotum reaching posterior margin of first dorsal abdominal segment. Forewings greyish black, with a lower rather large apical cell. Proportional length of dorsal abdominal segments (first to eighth):: 15: 32: 42: 46: 41: 45: 50: 52. Posterior margin of first dorsal abdominal segment well defined in the middle. Second segment with longitudinal carinae obliterated posteriorly; anteromesal impression shallow, anterolateral and posterolateral impressions small, clearly separated from each other; intersegmental groove between second and third segments shallow, sparsely longitudinally rugose. Third segment without longitudinal carinae; anteromesal impression shallow but distinct, anterolateral and posterolateral impressions subcontiguous, intersegmental groove between third and fourth segments almost as in the preceding one. Seventh dorsal abdominal segment transverse, its posterior margin rather deeply concave; seventh connexival segment with lateral margin rounded. Eighth segment with posterior margin broadly rounded. Metasternum behind transverse suture equal in length throughout.

Wingless female: Proportional length of dorsal abdominal segments (first to eighth):: 29: 38: 40: 40: 41: 41: 51: 51 (allotype). Metasternum behind transverse suture shortened medially.

Wingless male: Posterior margin of pronotum roundly concave, feebly produced in the middle. Posterior margin of mesonotum obliterated. Proportional length of dorsal abdominal segments (first to seventh):: 18: 21: 24: 24: 25: 29: 53 (holotype). Metasternum behind transverse suture shorter at middle, inclined posteriorly.

Rhagovelia janeira Drake

(Pl. 6, figs. 19a, b)

1953. *Rhagovelia janeira* Drake, Proc. Biol. Soc. Washington, vol. 66, pp. 151-152.

Winged male: Pronotum broadly rounded apically, reaching the middle of second dorsal abdominal segment. Forewings fuscous, lower apical cell is formed and relatively large. Proportional length of dorsal abdominal segments (second to seventh):: 25: 30: 31: 29: 32: 60. First dorsal abdominal segment with the median elevated area well defined posteriorly. Second dorsal abdominal segment with longitudinal carinae thick and rounded laterally; anteromesal impression obliterated, anterolateral impression transverse and obliquely placed, posterolateral impression small and clearly separated from anterolateral impression; intersegmental groove between second and third segments well impressed, its anterior margin zigzag. Third segment with anteromesal impression well-impressed and rounded, anterolateral and posterolateral impressions poorly developed and contiguous; longitudinal carinae obliterated before they reach the middle of the segment; intersegmental groove between third and fourth segments with anterior margin zigzag. Connexivum horizontally spread laterally. Metasternum behind transverse suture subequal in length throughout.

Wingless male: Posterior margin of pronotum concave. Mesonotum with posterior margin obliterated. Dorsal abdominal segments straightly narrowed posteriorly. Proportional length of dorsal abdominal segments (first to seventh):: 19: 23: 23: 23: 24: 28: 52 (holotype). Mesosternum behind transverse suture slightly lengthened laterally.

Winged female: Seventh dorsal abdominal segment distinctly longer than wide; seventh connexival segment with lateral margin slightly sinuate at middle, narrowed posteriorly. Eighth segment a little shorter than the preceding segment, posterior margin feebly rounded.

Wingless female: Pronotum with apex narrowly rounded, much more strongly produced posteriorly than in male. First dorsal abdominal segment with anterior margin strongly elevated and strongly produced in the middle, sinuate on either side of the middle. Connexivum strongly reflexed, completely covering sixth to eighth dorsal abdominal segments. Mesonotum behind transverse suture short, subequal in length throughout.

Rhagovelia longipes Gould

(Pl. 5, figs. 12a, b)

1931. *Rhagovelia longipes* Gould, Univ. Kansas Sci. Bull., vol. 20, p. 35.

Pronotum with apex not reaching first dorsal abdominal segment. Forewings fuscous, veins almost black, with one large apical cell. Proportional length of dorsal abdominal segments (first to eighth):: 15: 23: 22: 25: 23: 27: 48: 39. Connexivum rather strongly reflexed laterally. First dorsal abdominal segment with median elevated area defined laterally by a faint suture. Second dorsal abdominal segment with longitudinal carinae strongly divergent posteriorly, not reaching to posterior margin; anteromesal impression shallow, anterolateral and posterolateral impressions small, contiguous by a depression; intersegmental groove between second and third segments represented by a series of round and small impressions. Third dorsal abdominal segment with faint carinae running obliquely, not reaching to posterior margin; anteromesal impression obliterated, anterolateral and posterolateral impressions are represented by a contiguous laevigate, narrow impression along inner margin of third connexival segment; intersegmental groove between third and fourth segments well marked and with a series of small tubercles. Posterior margin of seventh dorsal abdominal segment strongly sinuate.

Wingless male: Posterior margin of mesonotum reaching anterior margin of first dorsal abdominal segment. Proportional length of dorsal abdominal segments (first to seventh):: 17(?): 18: 20: 20: 22: 29: 57.

Winged female: Seventh dorsal abdominal segment transverse, slightly narrowed posteriorly, lateral margin sinuate; seventh connexival segment with lateral margin rounded. Eighth segment with posterior margin subtruncate. Mesosternum behind transverse suture level, equal in length throughout, slightly lengthened near leg base.

Wingless female: Posterior margin of mesonotum subtruncate, not reaching to first dorsal abdominal segment. Proportional length of dorsal abdominal segments (first to eighth):: 25: 26: 30: 31: 31: 33: 41: 48.

Rhagovelia modesta Bacon

1956. *Rhagovelia modesta* Bacon, Univ. Kansas Sci. Bull., vol. 38, pt. I, p. 731.

Wingless male: Posterior margin of pronotum substraight, slightly produced posteriorly in the middle. Proportional length of dorsal abdominal segments (first to seventh):: 15: 15: 18: 22: 21: 27: 50. Metasternum behind transverse suture equal in length throughout.

Wingless female: Proportional length of dorsal abdominal segments (first to seventh):: 21: 18: 28: 31: 36: 39: 58. Metasternum behind transverse suture slightly lengthened medially.

Rhagovelia paulana Drake

(Pl. 6, figs. 18a, b)

1953. *Rhagovelia paulana* Drake, Proc. Biol. Soc. Washington, vol. 66, pp. 149-150.

Winged female: Pronotum reaching posterior margin of first dorsal abdominal segment. Forewings dark fuscous, forming a small apical cell, and it is often obsolete. Proportional length of dorsal abdominal segments (first to eighth):: 20: 32: 30: 32: 29: 27: 46: 35. First dorsal abdominal segment with median elevated area not well defined laterally, its posterior margin substraight. Second dorsal abdominal segment with longitudinal carinae slightly divergent posteriorly; anteromesal impression obliterated, anterolateral and posterolateral impressions rather small and clearly separated from each other; intersegmental groove between second and third segments distinctly impressed, posterior margin of the segment on either side of intersegmental groove rounded. Third dorsal abdominal segment without carinae, with a small anterolateral impression; intersegmental groove between third and fourth segments distinct, trisinuate on its anterior margin. Seventh dorsal abdominal segment a little longer than wide; seventh connexival segment strongly sinuate in the middle, reaching almost to the middle of eighth segment. Eighth segment distinctly wider at base than seventh segment, posterior margin gently rounded. The last genital segment elongate, rounded apically. Metasternum behind transverse suture subequal in length throughout.

Wingless male: Pronotum with posterior margin broadly sinuate. Mesonotum almost reaching to posterior margin of metanotum. Metanotum subequal in length throughout. Proportional length of dorsal abdominal segments (first to seventh):: 21: 22: 22: 21: 21: 24: 47 (holotype). Lateral margin of eighth segment slightly rounded.

Wingless female: Proportional length of dorsal abdominal segments (first to eighth):: 23: 31: 30: 27: 27: 27: 47: 40 (allotype). Connexivum behind second segment strongly reflexed on the dorsum. Mesosternum behind transverse suture as in winged female.

Rhagovelia plana Drake and Harris

1933. *Rhagovelia plana* Drake and Harris, Proc. Biol. Soc. Washington, vol. 46, p. 49.

Wingless male: Posterior margin of pronotum feebly concave, posterolateral margin feebly sinuate. Mesonotum with posterior margin obliterated. Abdomen substraightly narrowed apically. Proportional length of dorsal abdominal segments (first to eighth):: 15: 20: 20: 25: 23: 29: 50 (paratype). Metasternum behind transverse suture subequal in length throughout.

Wingless female: Proportional length of dorsal abdominal segments (first to eighth):: 20: 25: 26: 30: 33: 39: 45: 37. Connexivum strongly reflexed throughout.

Rhagovelia plumbea Uhler

1894. *Rhagovelia plumbea* Uhler, Proc. Zool. Soc. London, p. 217.

Wingless male: Pronotum with posterior margin feebly trisinuate. Mesonotum with posterior margin broadly rounded. Metanotum broadly exposed behind mesonotum. Proportional length of dorsal abdominal segments (first to eighth):: 20: 21: 20: 20: 20: 22: 39: 18. Oblique row of pubescence on mesosternum is lacking. Metasternum behind transverse suture strongly shortened medially, posterior margin of seventh ventral abdominal segment strongly roundly emarginated.

Wingless female: Posterior margin of pronotum trisinuate. Metanotum well exposed behind mesonotum. Proportional length of dorsal abdominal segments (first to eighth):: 28: 24: 24: 24: 28: 28: 37: 32. Connexivum strongly reflexed and folded on the dorsum. Metasternum behind transverse suture shortened medially as in male.

Remarks: This species has the following peculiar characteristics:

(1) Posterior margin of pronotum trisinuate.

(2) Metanotum well exposed behind mesonotum.

(3) A paired oblique row of pubescence on mesosternum is lacking.

(4) Metasternum behind transverse suture strongly shortened medially.

Rhagovelia salina (Champion)

1898. *Trochopus salinus* Champion, Biol. Centr. Amer., Het., vol. 2, p. 140.

Wingless male: Posterior margin of pronotum substraight. Posterior margin of mesonotum feebly sinuate leaving well exposed metanotum behind. Proportional length of dorsal abdominal segments (first to eighth):: 30: 30: 30: 30: 32: 37: 62: 42. Oblique row of long pubescence on mesosternum lacking. Metasternum behind transverse suture subequal in length throughout.

Wingless female: Proportional length of dorsal abdominal segments (first to eighth):: 32: 35: 35: 35: 35: 43: 57: 47. Connexivum more strongly reflexed than in male.

This species is easily distinguished from another marine form *Rh. plumbea* Drake and Harris in the following points besides the characteristics given by Bacon:

(1) Narrower body.

(2) Difference in proportional length in the seventh and eighth dorsal abdominal segments.

(3) Difference in the metasternum behind transverse suture.

This species, however, shares a common characteristic with *Rh. plumbea* in lacking the oblique row of long pubescence on the mesosternum.

Rhagovelia spinosa Gould

(Pl. 5, figs. 14a, b)

1931. *Rhagovelia spinosa* Gould, Univ. Kansas Sci. Bull., vol. 20, p. 43.

Winged male: Pronotum reaching near posterior margin of second segment, bluntly rounded apically. Forewings pale fuscous, veins nearly black, with two small well-defined apical cells. Proportional length of dorsal abdominal segments (second to seventh):: 28: 21: 23: 23: 28: 49. First dorsal abdominal segment with median elevated area feebly bisinuate on posterior margin. Second dorsal abdominal segment with longitudinal carinae roundly divergent posteriorly; anteromesal and anterolateral impressions well-marked and connected by the depression along posterior margin of first segment, posterolateral impression small. Third dorsal abdominal segment with longitudinal carinae less distinct than those on second segment, but almost reaching to posterior margin of third segment; anteromesal, anterolateral and posterolateral impressions contiguous by distinct depression connecting them; intersegmental groove between second and third segments and that between third and fourth segments are well marked, with a series of round impressions on them. The last connexival segment with lateral margin slightly sinuate.

Wingless male: Posterior margin of pronotum obliterated. Proportional length of dorsal abdominal segments (first to seventh):: 17: 20: 20: 20: 22: 22: 43 (holotype). Connexivum slightly reflexed.

Winged female: Seventh dorsal abdominal segment slightly narrowed posteriorly; seventh connexival segment with apical margin sinuate. Eighth segment about as long as the preceding segment; paratergite well defined and large.

Wingless female: Connexivum more strongly reflexed than in male, but does not hide tergites beneath. Proportional length of dorsal abdominal segments (first to eighth):: 21: 25: 26: 31: 35: 38: 52: 45. Metasternum behind transverse suture subequal in length throughout.

Remarks: This species is characteristic among the representatives of *angustipes* group in the following points:

(1) Male both in winged and wingless forms is armed with a prominent tubercle at base of seventh ventral abdominal segment.

(2) Third dorsal abdominal segment in winged form occasionally with distinct longitudinal carinae which almost reach to posterior margin of the same segment.

(3) Spiracle on seventh segment placed distinctly closer to anterior margin than to posterior margin.

(4) Well-defined and large paratergite on eighth abdominal segment in winged female.

Rhagovelia tantilla Drake and Harris

(Pl. 6, figs. 17a, b)

1933. *Rhagovelia tantilla* Drake and Harris, Proc. Biol. Soc. Washington, vol. 46, p. 49.

Winged female: Pronotum reaching the middle of second dorsal abdominal segment. Forewings fuscous, with one closed small apical cell. Proportional length of dorsal abdominal segments (first to eighth):: 12: 31: 27: 27: 33: 37: 43: 51. Second dorsal abdominal segment with longitudinal carinae not reaching to posterior margin of the same segment; anteromesal impression obsolete, anterolateral and posterolateral impressions are subcontiguous; intersegmental groove inconspicuous, with a pair of transverse laevigate spots located behind posterior end of longitudinal carina on intersegmental groove. Third segment without longitudinal carinae, anterolateral and posterolateral impressions continuous, inconspicuous. Connexivum reflexed vertically. Eighth segment with posterior margin broadly rounded. Metasternum behind transverse suture short, slightly shortened medially.

Wingless male: Posterior margin of pronotum broadly concave. Mesonotum fused with metanotum posteriorly. Proportional length of dorsal abdominal segments (first to eighth):: 24: 24: 25: 26: 33: 38: 48: 48. Metasternum behind transverse suture slightly shortened medially. First and second dorsal abdominal segments strongly elevated, posterior margin of first segment broadly rounded.

Wingless female: Proportional length of dorsal abdominal segments (first to eighth):: 28: 25: 25: 26: 35: 40: 45: 48. Connexivum strongly reflexed. Metasternum behind transverse suture shortened medially.

Rhagovelia tenuipes Champion

(Pl. 6, figs. 15a, b)

1898. ***Rhagovelia tenuipes*** Champion, Biol. Centr. Amer., Het. vol. 2, p. 137.

Winged male: Pronotum reaching first dorsal abdominal segment. Forewings purplish black, apical cell not formed. Proportional length of dorsal abdominal segments (first to eighth):: 15: 30: 26: 26: 27: 32: 51: 46. First dorsal abdominal segment with median elevated area inclined posteriorly. Second dorsal abdominal segment with longitudinal carinae divergent posteriorly; anteromesal impression shallow, anterolateral and posterolateral impressions well marked; intersegmental groove between second and third segments obscurely longitudinally rugose. Third segment with longitudinal carinae poorly developed, not reaching the middle of the segment; anteromesal impressions contiguous; intersegmental groove between third and fourth segments well marked, evanescent laterally.

Wingless male: Pronotum with posterior margin broadly sinuate, posterior margin of mesonotum indistinguishably fused with metanotum. Proportional length of dorsal abdominal segments (first to seventh):: 19: 22: 22: 24: 25: 28: 50. Connexivum strongly reflexed. Metasternum as in winged male.

Winged female: Seventh dorsal abdominal segment longer than eighth segment, Posterior margin of eighth segment broadly rounded. Metasternum behind transverse suture short, slightly lengthened near leg base.

Wingless female: Proportional length of dorsal abdominal segments (first to eighth):: 25: 30: 32: 34: 36: 42: 47: 43.

Rhagovelia velocis Drake and Harris

1935. ***Rhagovelia velocis*** Drake and Harris, Proc. Biol. Soc. Washington, vol. 48, p. 36.

Wingless male: Pronotum with posterior margin broadly sinuate, posterior margin of mesonotum indistinguishably fused with metanotum. Proportional length of dorsal abdominal segments (first to seventh:: 25: 28: 24: 23: 25: 31: 53. Anterior margin of first segment feebly sinuate, feebly produced in the middle. Metasternum behind transverse suture shortened in the middle.

Wingless female: Proportional length of dorsal abdominal segments (first to eighth):: 29: 31: 32: 30: 32: 40: 52: 45. Metasternum as in wingless male.

Rhagovelia versuta Drake and Harris

(Pl. 3, figs. 3, 4; pl. 6, figs. 16a, b)

1935. *Rhagovelia versuta* Drake and Harris, Proc. Biol. Soc. Washington, vol. 48, p. 37.

Winged female: Pronotum bluntly rounded apically, covering first dorsal abdominal segment beneath. Forewings black, with purplish tinge, veins with conspicuous hairs, with one rather obscurely defined apical cell, subcosta reaching the middle of upper margin of forewing. Proportional length of dorsal abdominal segments (first to eighth):: 22: 40: 40: 44: 46: 45: 61: 52. Second dorsal abdominal segment with longitudinal carinae divergent and narrowed posteriorly, with longitudinal rugosities behind posterior margin of median elevated area of first dorsal abdominal segment, anteromesal impression obsolete, anterolateral and posterolateral impressions separated; intersegmental groove between second and third segments with distinct longitudinal rugosities. Third segment with longitudinal carinae narrower, traceable as far as middle of the segment or sometimes almost reaching posterior margin of third segment; anterolateral and posterolateral impressions contiguous; intersegmental groove between third and fourth segments is represented by a series of round impressions, evanescent laterally. Seventh connexival segment elongate subtriangular, with a bundle of long black hairs at apex. Eighth segment with apex broadly rounded. Metasternum behind transverse suture short.

Wingless female: Proportional length of dorsal abdominal segments (first to seventh):: 30: 35: 33: 31: 32: 40: 70. Metasternum as in winged female.

Winged male: Proportional length of dorsal abdominal segments (third to seventh):: 32: 34: 31: 37: 61. Connexivum reflexed in the same degree as in female.

Wingless male: Posterior margin of pronotum broadly sinuate. Posterior margin of mesonotum sinuate. Proportional length of dorsal abdominal segments (first to seventh):: 25: 32: 30: 27: 29: 34: 64. Anterior margin of first dorsal abdominal segment feebly bisinuate. Posterior margin of eighth segment broadly rounded. Metasternum as in winged male.

Rhagovelia viriosa Bacon

1956. *Rhagovelia viriosa* Bacon, Univ. Kansas Sci. Bull., vol. 38, pt. I. p. 751.

Wingless male: Posterior margin of pronotum concave. Posterior margin of mesonotum reaching to anterior margin of first dorsal abdominal segment which is feebly sinuate. Proportional length of dorsal abdominal segments (first to eighth):: 30: 33: 33: 35: 36: 42: 80: 70. Metasternum behind transverse suture lengthened laterally near leg base.

Wingless female: Proportional length of dorsal abdominal segments (first to seventh):: 30: 40: 40: 50: 53: 60: 75. Anterior margin of first dorsal abdominal segment straight. Metasternum behind transverse suture subequal in length throughout.

GROUP CHARACTERISTICS OF THE ABRUPTA GROUP

The following three species out of seven species treated by Bacon were available for the study of winged forms: *Rh. abrupta* Gould, *Rh. trista* Gould, *Rh. vivata* Bacon.

In all three species the distinct longitudinal carinae occur on the second dorsal abdominal segment, the carinae on the third segment, when present, are poorly developed (*Rh. abrupta*) or traceable as a series of fine tubercles (*Rh. trista*). The forewing venation is essentially the same as that in the *angustipes* group. Two apical cells are always formed in the proximal half of the wing and the subcosta never develops beyond the basal half of the anterior margin of the wing. The pronotum in winged forms is bluntly rounded apically as in the *angustipes* group.

The proportional length of the sixth and seventh dorsal abdominal segments in winged males ranges from about 2:3 to about 7:8 except for *Rh. lucida* in which the third segment is much longer than the second one (43:29).

In the intermediate leg the third tarsal segment is always longer than the second one.

In the hind leg the femur is distinctly longer than the tibia except for *Rh. lucida* in which the femur is just slightly longer than the tibia (100:97).

The following characters are also peculiar to this group:

(1) Slender body except for *Rh. lucida.*

(2) Pronotum short, but longer than in the *angustipes* group, its posterior margin always roundly produced posteriorly.

(3) The anterior margin of first dorsal abdominal segment roundly produced anteriorly.

(4) The seventh dorsal abdominal segment in female, in both winged and wingless forms, is elongate except for *Rh. lucida.*

Rh. lucida apparently deviates strongly from other species of this group in many characters, as noted above, and this will be further noted in the description of this species.

The *abrupta* group is identical in the characters of the dorsal abdominal segments and wing venation with the *angustipes* group, but differs from it as follows:

(1) The pronotum in wingless forms is longer and its posterior margin roundly produced posteriorly.

(2) The hind femur is longer than the hind tibia in all species.

(3) The metasternum behind the transverse suture is inclined posteriorly.

Rhagovelia abrupta Gould

(Pl. 3, fig. 7; pl. 7, figs. 20a, b)

1933. *Rhagovelia hungerfordi* Gould, Ann. Ent. Soc. America, vol. 26, p. 467.

Winged female: Forewings totally purplish black, veins darker, with two well-defined apical cells, of which the lower one is larger than the upper one. Proportional length of dorsal abdominal segments (first to eighth):: 16: 37: 42: 48: 56: 64: 75: 49. Longitudinal carinae thick, roundly divergent posteriorly in second segment; anteromesal impression shallow, continuous with anterolateral impression by groove along posterior margin of first segment, posterolateral impression small, distinctly separated from anterolateral impression; intersegmental groove between second and third segments well defined, finely granulated. Third segment with longitudinal carinae obsolete behind the middle of the segment; three laevigate impressions continuous by groove along posterior margin of second dorsal abdominal segment and inner margin of third connexival segment; intersegmental groove between third and fourth segments well defined and laevigate. Seventh dorsal abdominal segment with posterior margin straight; seventh connexival segment with lateral margin straight, apex densely clothed with dark and long hairs. Eighth segment with posterior margin broadly rounded.

Wingless female: Proportional length of dorsal abdominal segments (first to eighth):: 35: 39: 40: 45: 60: 71: 80: 50. Sixth, seventh and eighth dorsal abdominal segments longer than wide.

Winged male: Proportional length of dorsal abdominal segments (third to eighth):: 35: 35: 38: 45: 75: 95. Metasternum behind transverse suture inclined posteriorly and shortened medially.

Wingless male: Proportional length of dorsal abdominal segments (first to eighth):: 32: 35: 33: 32: 35: 41: 68: 80. Anterior margin of first dorsal abdominal segment slightly roundly produced anteriorly. Metasternum as in winged male.

Rhagovelia lucida Gould

1931. *Rhagovelia lucida* Gould, Univ. Kansas Sci. Bull., vol. 20, p. 36.

Wingless male: Proportional length of dorsal abdominal segments (first to seventh):: 38: 28: 28: 24: 25: 32: 65. First dorsal abdominal segment rounded both on anterior and posterior margins. Metasternum behind transverse suture inclined posteriorly, slightly shortened medially.

Wingless female: Proportional length of dorsal abdominal segments (first to eighth):: 50: 30: 30: 26: 23: 35: 65: 57. First dorsal abdominal segment roundly produced anteriorly. Seventh segment inclined posteriorly. Connexivum subvertically erected. Metasternum behind transverse suture level, slightly shortened medially.

Remarks: Abnormally long first dorsal abdominal segment, considerably deviated proportional length of sixth and seventh dorsal abdominal segments in both sexes, hooklike apex of clasper, much deviated proportional length between hind femur and tibia, much longer third antennal segment than second segment are characteristic of this species which breaks close relationship with any other representative of this group.

Rhagovelia torquata Bacon

1948. *Rhagovelia torquata* Bacon, Jour. Kansas Ent. Soc., vol. 21, no. 3, p. 83.

Wingless male: Proportional length of dorsal abdominal segments (first to eighth):: 28: 30: 30: 30: 32: 38: 50: 45 (holotype). First dorsal abdominal segment produced anteriorly.

Wingless female: Proportional length of dorsal abdominal segments (first to eighth):: 34: 37: 39: 38: 43: 57: 65: 42. Metasternum behind transverse suture inclined posteriorly, shortened medially.

Rhagovelia trepida Bacon

1948. *Rhagovelia trepida* Bacon, Jour. Kansas Ent. Soc., vol. 21, no. 3, p. 84.

Wingless male: Proportional length of dorsal abdominal segments (first to eighth):: 36: 38: 33: 32: 32: 32: 38: 65 (holotype). Metasternum behind transverse suture inclined posteriorly, slightly shortened medially. All ventral abdominal segments are longitudinally elevated in the middle.

Wingless female: Proportional length of dorsal abdominal segments (first to eighth):: 37: 40: 35: 37: 50: 38: 60: 42 (allotype). Metasternum behind transverse suture not inclined posteriorly. Last three dorsal abdominal segments as in *Rh. trista.* Seventh dorsal abdominal segment elongate, narrowed apically. Eighth segment with posterior margin broadly rounded.

Rhagovelia trista Gould

(Pl. 7, figs. 22a, b)

1931. ***Rhagovelia trista*** Gould, Univ. Kansas Sci. Bull., vol. 20, p. 45.

Winged female: Forewings greyish fuscous, with two well-defined apical cells. Proportional length of dorsal abdominal segments (second to eighth):: 37: 32: 34: 40: 47: 52: 40. First dorsal abdominal segment with median elevated area roundly sinuate on posterior margin. Second segment with longitudinal carinae narrow and rounded; anteromesal impression obliterated, anterolateral and posterolateral impressions clearly separated; intersegmental groove between second and third segments without rugosity. Third segment with a faint series of fine tubercles disposed obliquely behind posterior end of longitudinal carinae on second segment, anterolateral and posterolateral impressions contiguous. Seventh dorsal abdominal segment longer than wide, widened posteriorly, longer than eighth segment; seventh connexival segment with lateral margin straight. Eighth segment with posterior margin broadly rounded. Metasternum behind transverse suture inclined posteriorly, subequal in length throughout.

Wingless female: Proportional length of dorsal abdominal segments (first to eighth):: 30: 33: 33: 36: 42: 52: 58: 45 (allotype). Anterior margin of first dorsal abdominal segment substraight. Apical three segments much as in winged form. Connexivum subvertically erected. Metasternum behind transverse suture as in winged female.

Wingless male: Proportional length of dorsal abdominal segments (first to seventh):: 28: 30: 27: 27: 30: 33: 45 (paratype). Metasternum behind transverse suture inclined posteriorly, slightly shortened in the middle.

Rhagovelia vivata Bacon

(Pl. 7, figs. 21a, b)

1948. ***Rhagovelia vivata*** Bacon, Jour. Kansas Ent. Soc., vol. 21, no. 3, p. 85.

Winged male: Forewings fuscous, veins darker, with two distinct apical cells as in *Rh. abrupta.* Proportional length of dorsal abdominal segments (second to eighth):: 42: 38: 37: 47: 52: 65: 47. Second dorsal abdominal segment with longitudinal carinae narrow, reaching posterior margin of second segment; anteromesal impression obliterated, narrowly impressed along posterior margin of first segment on either side of carinae, anterolateral and posterolateral impressions well sculptured and subcontiguous; intersegmental groove between second and third segments finely granulated. Third segment without carinae. Anterolateral and posterolateral impressions smaller and continuous; intersegmental groove between third and fourth segments finely granulated. Metasternum behind transverse suture inclined posteriorly, shortened medially. Seventh ventral abdominal segment about as long as two preceding segments combined.

Wingless male: Proportional length of dorsal abdominal segments (first to seventh):: 31: 34: 33: 28: 35: 41: 63. Metasternum behind transverse suture inclined posteriorly, shortened medially.

Winged female: Seventh dorsal abdominal segment with anterior margin rounded, posterior margin sinuate, about 1½ times as long as eighth segment (60:42), slightly narrowed apically; seventh connexival segment with lateral margin straight. Eighth segment with posterolateral margin feebly rounded.

Wingless female: Proportional length of dorsal abdominal segments (first to eighth):: 31: 33: 35: 37: 47: 60: 70: 47 (allotype). First dorsal abdominal segment straight or feebly produced.

GROUP CHARACTERISTICS OF THE HIRTIPES GROUP

The only representative of this group *Rh. hirtipes* Drake and Harris has the following peculiar characters which are not shared by any one group of the genus *Rhagovelia*:

(1) Longitudinal carinae occur only in the second dorsal abdominal segment and reach to the middle of the segment.

(2) The median elevated area of the first dorsal abdominal segment is obscurely defined laterally.

(3) The last genital segment is bent back and completely telescoped on the ventral surface of the eighth abdominal segment.

(4) The seventh dorsal abdominal segment is twice as long as the eighth segment in the wingless female.

(5) The third and fourth dorsal abdominal segments in the winged female is strongly depressed laterally.

(6) The dorsum is longitudinally carinate in the middle after the first two segments in the female.

(7) The connexivum after the fifth segment is strongly reflexed, narrowed and lustrous.

(8) The dorsal surface of the abdomen in winged forms is much the same as in the wingless form in both sexes.

(9) The shape of the male clasper is much different from that of any other species of this genus.

This species, however, has the following characters in common with the majority of the *angustipes* group:

(1) The second tarsal segment is about as long as the third one in the intermediate leg.

(2) The femur is shorter than the tibia in the hind leg.

(3) The metasternum behind the transverse suture is level.

Rhagovelia hirtipes Drake and Harris

(Pl. 7, figs. 23a, b)

1927. *Rhagovelia hirtipes* Drake and Harris, Proc. Biol. Soc. Washington, vol. 40, p. 136.

Winged female: Pronotum with apex rounded, clothed with long, dark brown hairs. Proportional length of dorsal abdominal segments (first to eighth):: 27: 39: 40: 39: 42: 45: 63: 43. First segment with median elevated area rather narrow, laterally obliquely defined. Second segment with longitudinal carina thick, reaching just to the middle of second segment; anteromesal impression is represented by a small, round impression; anterolateral and posterolateral impressions contiguous along inner margin of second connexival segment. Third and fourth segments strongly and widely depressed on either side of median longitudinal axis. Seventh segment much longer than eighth segment (63:43), posterior margin feebly sinuate. Eighth segment with posterior margin rounded and armed with two pairs of conspicuous bundles of long, black hairs directed more or less downwardly. Connexivum in basal five segments oblique, then strongly reflexed, narrowed and polished posteriorly, clothed with long brown hairs. Seventh connexival segment near apex with rather conspicuous bundle of hairs. The last genital segment turned completely downwards and folded on the ventral surface of eighth abdominal segment. Metasternum behind transverse suture level, subequal in length throughout, slightly shorter in the middle.

Wingless female: Proportional length of dorsal abdominal segments (first to eighth):: 53: 42: 37: 44: 49: 61: 73: 37. Second dorsal abdominal segment with posterior region subvertically inclined posteriorly. Third and fourth segments depressed laterally as in winged form. Connexivum vertically reflexed after fourth segment. Posterior margin of eighth segment densely clothed with pale brown hairs. The last segment as in winged form.

Winged male: Proportional length of dorsal abdominal segments (first to seventh):: 19: 40: 40: 34: 39: 43: 63. Connexivum less strongly reflexed than in female. Third and fourth dorsal abdominal segments without conspicuous lateral depression as in female. Metasternum behind transverse suture inclined posteriorly, strongly shortened medially. Seventh ventral abdominal segment shallowly depressed on either side of middle, posterior margin nearly straight.

Wingless male: Proportional length of dorsal abdominal segments (first to seventh):: 28: 39: 37: 35: 37: 40: 60, posterior margin of each segment except for sixth and seventh segments bisinuate. Metasternum and ventral side of abdomen as in winged male.

GROUP CHARACTERISTICS OF THE ELEGANS GROUP

The following three species of this group were available for the study of winged forms: *Rh. insularis* Champion; *Rh. elegans* Uhler; *Rh. uncinata* Champion.

Pronotum in winged forms without apical process, with obscure longitudinal ridge throughout the entire length. Pronotum in wingless forms broadly rounded apically, sometimes not completely covering the mesonotum beneath (*Rh. insularis*).

Forewings with two well-developed apical cells formed at the basal region of distal half of the wing.

Longitudinal carinae occur always on the second and third segments, continuous and fine; intersegmental groove finely and longitudinally rugulose.

The following characters are also peculiar to this species group:

(1) The species is of large size.

(2) The winged forms are relatively abundant.

(3) The dorsum of the abdomen of the wingless female tapers rather evenly to the apex.

(4) The anterior margin of the first dorsal abdominal segment is roundly produced.

(5) The metasternum behind the transverse suture is inclined posteriorly, the transverse suture being more or less sinuate on either side of the middle.

(6) The anterior margin of metasternum always slightly produced anteriorly.

(7) The proportional length between the sixth and seventh abdominal segments in winged males range from 53:67 in *Rh. insularis*

to 55:67 in *Rh. uncinata;* that in wingless males from 53:73 in *Rh. elegans,* to 53:67 in *Rh. insularis.* The proportional length between the seventh and eighth segments in winged females range from 55:45 in *Rh. insularis,* to 63:51 in *Rh. uncinata,* that in wingless females from 62:50 in *Rh. elegans* and *Rh. uncinata,* to 43:48 in *Rh. insularis.*

(8) The seventh connexival segment with inner margin is always produced inwardly in the middle, its lateral margin rounded in the winged female.

(9) In the intermediate leg the third tarsal segment is distinctly longer than the second one.

(10) In the intermediate leg the tibia is more than twice as long as the second tarsal segment.

(11) In the hind leg the femur and the tibia are subequal in length.

Rhagovelia elegans Uhler

(Pl. 8, figs. 25a, b)

1894. ***Rhagovelia elegans*** Uhler, Proc. Zool. Soc. London, p. 216.

Winged male: Forewings almost black, with two large apical cells. Proportional length of dorsal abdominal segments (first to seventh):: 23: 53: 57: 62: 60: 67: 80. First segment emarginated on posterior margin. Second segment with median longitudinal carinae thin, roundly produced laterally at middle, continuous with those on third segment; anteromesal impression continuous with anterolateral impression by depression along posterior margin of first segment, anterolateral and posterolateral impressions separated but connected by depression along inner margin of second connexival segment; intersegmental groove between second and third segments finely and longitudinally rugulose, its anterior margin produced. Third segment with longitudinal carinae slightly divergent posteriorly; anteromesal, anterolateral and posterolateral impressions continuous; intersegmental groove between third and fourth segments finely longitudinally rugulose, its anterior margin slightly produced in the middle. Metasternum behind transverse suture as in *Rh. insularis.*

Wingless male: Proportional length of dorsal abdominal segments (first to seventh):: 43: 50: 50: 52: 53: 53: 73.

Winged female: Seventh dorsal abdominal segment about as long as wide, posterior margin slightly sinuate; seventh connexival segment with inner margin rather strongly produced inwardly, lateral margin rounded, sparsely clothed with long hairs. Eighth segment with posterior margin broadly rounded.

Wingless female: Seventh dorsal abdominal segment about as long as wide, posterior margin slightly sinuate; seventh connexival segment with inner margin rather strongly produced inwardly, lateral margin rounded, sparsely clothed with long hairs. Eighth segment with posterior margin broadly rounded.

This species is closely related to *Rh. insularis,* but may be distinguished from the latter in the following points in addition to the characters given by Bacon:

(1) All spiracles from third to seventh segments in this species are placed midway between anterior and posterior margins.

(2) First dorsal abdominal segment with median elevated area longer in this species.

Rhagovelia insularis Champion

(Pls. 1, 2; pl. 3, figs. 1, 2; pl. 8, figs. 27a, b)

1898. *Rhagovelia insularis* Champion, Biol. Centr. Amer., Het., vol. 2, p. 135.

Winged male: Pronotum with apex reaching basal region of second dorsal abdominal segment, narrowly rounded. Forewings dark fuscous, veins black, with two distinct apical cells formed beyond the middle of the wing. Proportional length of dorsal abdominal segments (first to eighth):: 13: 51: 51: 51: 51: 53: 67: 57. First dorsal abdominal segment short, with median elevated region roundly concave on posterior margin. Second segment with longitudinal carinae narrow, rather strongly produced laterally in apical half; anteromesal impression obsolete, anterolateral and posterolateral impressions separate from each other; intersegmental groove between second and third segments finely rugulose. Third segment with longitudinal carinae less strongly divergent posteriorly than in second segment; anteromesal impression distinct, anterolateral and posterolateral impressions are continuous; intersegmental groove between third and fourth segments finely longitudinally rugulose. Posterior margin of seventh segment nearly straight. Connexivum rather flattened, lateral margin of each segment more or less rounded. Metasternum behind transverse suture strongly inclined posteriorly and shortened in the middle, with a distinct longitudinal elevation in the middle.

Wingless male: Proportional length of dorsal abdominal segments (first to seventh):: 42: 48: 48: 48: 48: 53: 65. First dorsal abdominal segment roundly produced anteriorly. Metasternum as in winged male.

Winged female: Proportional length of dorsal abdominal segments (first to eighth):: 17: 57: 53: 56: 55: 58: 55: 45. Seventh dorsal abdominal segment with lateral margin sinuate in posterior half, posterior margin strongly sinuate; seventh connexival segment with lateral margin feebly rounded. Eighth segment with posterolateral margin feebly rounded, posterior margin feebly sinuate. Connexivum reflexed. Metasternum behind transverse suture strongly inclined posteriorly, strongly and straightly shortened medially.

Wingless female: Proportional length of dorsal abdominal segments (first to eighth):: 42: 43: 50: 50: 48: 50: 53: 48. Pronotum not reaching posterior margin of mesonotum.

Rhagovelia uncinata Champion

(Pl. 8, figs. 26a, b)

1898. *Rhagovelia uncinata* Champion, Biol. Centr. Amer., Het., vol. 2, p. 135.

Winged male: Forewings dark fuscous, veins black, with two well-defined apical cells. Proportional length of dorsal abdominal segments (first to seventh):: 20: 51: 48: 55: 51: 55: 63. Second segment with longitudinal carinae slender, gently roundly produced laterally in the middle; anteromesal impression small but distinct, anteromesal and anterolateral impressions connected by depression along posterior margin of first segment, posterolateral impression clearly separated from anterolateral impression, oval in shape; intersegmental groove finely longitudinally rugulose; disk obscurely transverse-obliquely rugose. Third segment with longitudinal carinae continuous with those on second segment, fine, gently roundly produced laterally in the middle; anteromesal impression distinct; anterolateral and posterolateral impressions subcontiguous; intersegmental groove finely longitudinally rugulose; disk obscurely transversely rugose. Metasternum with transverse suture slightly sinuate on either side of the middle; the area posterior to transverse suture strongly inclined posteriorly, its caudal margins straight, oblique and meeting at an angle medially. All spiracles from third to seventh segments located midway between anterior and posterior margin of each segment.

Winged female: Proportional length of dorsal abdominal segments (third to eighth):: 50: 56: 56: 63: 63: 51. Seventh dorsal abdominal segment widened posteriorly, lateral margin sinuate at middle; seventh connexival segment with lateral margin rounded. Eighth segment with posterolateral margin sinuate, posterior margin slightly rounded. Lateral margin of seventh and eighth segments sparsely clothed with long hairs.

Wingless female: Pronotum almost covers mesonotum beneath. Proportional length of dorsal abdominal segments (first to eighth):: 40: 47: 48: 50: 52: 57: 62: 50. First dorsal abdominal segment with anterior margin roundly produced anteriorly. Connexivum strongly reflexed. Metasternum behind transverse suture strongly inclined posteriorly, strongly shortened medially.

Rhagovelia merga Bacon

1956. *Rhagovelia merga* Bacon, Univ. Kansas Sci. Bull., vol. 38, pt. I, p. 774.

Wingless male: Proportional length of dorsal abdominal segments (first to sixth):: 40: 53: 50: 49: 49: 55 (holotype). First dorsal abdominal segment with anterior margin nearly straight.

GROUP CHARACTERISTICS OF THE CRASSIPES GROUP

The following species were available for the study of winged forms:

Rh. crassipes Champion
Rh. horrida Bacon
Rh. jubata Bacon
Rh. nitida Bacon
Rh. palea Bacon
Rh. perfidiosa Bacon
Rh. sinuata Gould
Rh. varipes Champion

In this group *Rh. nitida* deviates considerably in some characters from other species of this group defined by Bacon, as will be noted in connection with the description of this species. When this species is excluded the group becomes increasingly homogeneous as is characterized below.

Pronotum in winged form without apical projection except for the female of *Rh. crassipes.* Pronotum entirely covers mesonotum in wingless forms.

Forewings always with two large apical cells formed in distal half of the wing.

Longitudinal carinae fine but well defined, always occur on second and third segments; anterolateral and posterolateral impressions are always clearly separated.

Connexivum never folded on the dorsum in wingless forms. Seventh dorsal abdominal segment about as long as wide or wider than long; seventh connexival segment gradually narrowed apically, never strongly produced posteriorly. Proportional length of sixth and seventh dorsal abdominal segments in winged male ranges from 35:55 in *Rh. perfidiosa* to 78:85 in *Rh. crassipes,* that in wingless male from 30:52 in *Rh. perfidiosa* to 58:65 in *Rh. williamsi.* Proportional length of seventh and eighth segments in winged female ranges from 87:85 in *Rh. varipes* to 78: 60 in *Rh. crassipes,* that in wingless female from 85:70 in *Rh. varipes* to 48:70 in *Rh. williamsi.*

In intermediate leg third tarsal segment is always longer than second one; tibia is always more than twice as long as second tarsal segment.

In hind leg femur always longer than tibia.

Rhagovelia crassipes Champion

(Pl. 9, figs. 28a, b, c)

1898. *Rhagovelia crassipes* Champion, Biol. Centr. Amer. Het., vol. 2, p. 133.

Winged female: Pronotum with apex erected, acutely pointed, with a small process at base of apical process. Forewings fuscous, veins darker, with two well-defined elongate cells in distal half. Proportional length of dorsal abdominal segments (first to eighth):: 25: 55: 70: 78: 75: 82: 78: 60. First dorsal abdominal segment with median elevated area feebly sinuate on posterior margin. Second segment with longtitudinal carinae slightly divergent posteriorly, forked into two arms on intersegmental groove, embracing partly a shallow, round depression, obscurely depressed along posterior margin of first segment, anteromesal impression small, anterolateral impression transverse, posterolateral impression placed in the depression, clearly separated from anterolateral impression; intersegmental groove shallow, ill-defined. Third segment with longitudinal carinae arising from inner apical arm of the carinae on second abdominal segment, forked posteriorly, inner branch is more conspicuous; intersegmental groove between third and fourth segments shallow; anteromesal laevigate impression absent, anterolateral and posterolateral impressions shallow, placed in obscurely defined depression along third connexival segment. Seventh dorsal abdominal segment a little wider than long, subquadrangular in shape; seventh connexival segment gradually narrowed apically, inner margin sinuate, lateral margin rounded and densely clothed with brown hairs which become longer posteriorly. Eighth segment with paratergite clothed with long hairs on dorsal surface; posterior margin of eighth segment broadly rounded. Posterior margin of seventh and eighth ventral abdominal segments with small black tubercles at sides. The last genital segment gradually narrowed apically, apex narrowly rounded. Metasternum behind transverse suture without distinct median longitudinal elevation, inclined posteriorly, longer laterally near leg base.

Wingless female: Proportional length of dorsal abdominal segments (first to eighth):: 52: 60: 70: 70: 75: 80: 80: 60. Connexivum a little more strongly reflexed than in winged male. Abdomen on ventral side as in winged female.

Winged male: Pronotum with the apex less strongly produced posteriorly. Proportional length of dorsal abdominal segments (first to seventh):: 25: 55: 68: 73: 72: 75: 85. Seventh dorsal abdominal segment strongly widened posteriorly, lateral margin sinuate. Ventral abdominal segment with median longitudinal elevation. Metasternum behind transverse suture strongly inclined posteriorly, strongly shortened in the middle. Dorsolateral and ventrolateral margins of seventh abdominal segment with a series of minute black spines directed inwardly.

Wingless male: Pronotum completely covers mesonotum. Proportional length of dorsal abdominal segments (first to seventh):: 58: 73: 73: 72: 71: 80: 95. Anterior margin of first dorsal abdominal segment roundly produced anteriorly. Abdomen on ventral side as in winged female.

Rhagovelia amazonensis Gould

1931. *Rhagovelia amazonensis* Gould, Univ. Kansas Sci. Bull., vol. 20, p. 15.

Wingless male: Proportional length of dorsal abdominal segments (first to seventh):: 31: 37: 35: 30: 34: 37: 56 (holotype). Pronotum entirely covering mesonotum. Connexivum reflexed laterally at an angle of about forty-five degrees. Metasternum behind transverse suture inclined posteriorly and shorter at middle. Without median longitudinal ridge on venter. Seventh and eighth ventral abdominal segments without black spines.

Wingless female: Proportional length of dorsal abdominal segments (first to eighth):: 35: 37: 40: 38: 43: 47: 55: 48 (allotype). Anterior margin of first dorsal abdominal segment broadly rounded and produced anteriorly. Apex of seventh connexival segment and lateral margin of eighth dorsal abdominal segments with thick bundle of black setae. Metasternum as in wingless male.

Rhagovelia castanea Gould

1931. *Rhagovelia castanea* Gould, Univ. Kansas Sci. Bull., vol. 20, p. 19.

Wingless male: Pronotum entirely covers mesonotum. Proportional length of dorsal abdominal segments (first to seventh):: 44: 46: 41: 40: 43: 48: 76 (holotype). Connexivum slightly reflexed laterally. Metasternum behind transverse suture shorter at middle. Venter without median longitudinal carina. Seventh and eighth ventral abdominal segments without a row of black spines on posterior margin.

Wingless female: Pronotum as in wingless male. Proportional length of dorsal abdominal segments (first to eighth):: 45: 43: 41: 43: 49: 59: 72: 59 (allotype). Eighth segment with posterior margin broadly rounded.

Wingless female: Proportional length of dorsal abdominal segments (first to eighth):: 52: 60: 70: 70: 75: 80: 80: 60. Connexivum a little more strongly reflexed than in winged male. Abdomen on ventral side as in winged female.

Winged male: Pronotum with apex less strongly produced posteriorly. Proportional length of dorsal abdominal segments (first to seventh):: 25: 55: 68: 73: 72: 75: 85. Seventh dorsal abdominal segment strongly widened posteriorly, lateral margin sinuate. Ventral abdominal segments with median longitudinal elevation. Metasternum behind transverse suture strongly inclined posteriorly, strongly shortened in the middle. Dorsolateral and ventrolateral margins of seventh abdominal segment with a series of minute black spines directed inwardly.

Wingless male: Pronotum completely covers mesonotum. Proportional length of dorsal abdominal segments (first to seventh):: 58: 73: 73: 72: 71: 80: 95. Anterior margin of first dorsal abdominal segment roundly produced anteriorly. Abdomen on ventral side as in winged female.

Rhagovelia femoralis Champion

1898. *Rhagovelia femoralis* Champion, Biol. Centr. Amer., Het., vol. 2, p. 138.

Wingless male: Proportional length of dorsal abdominal segments (first to seventh):: 40: 48: 46: 44: 45: 51: 80. Connexivum reflexed at angle of forty-five degrees laterally. Venter with distinct median longitudinal elevation clothed with long hairs throughout second to sixth segments. Seventh ventral abdominal segment without row of black spines on posterior margin.

Rhagovelia horrida Bacon

(Pl. 10, figs. 33a, b)

1956. *Rhagovelia horrida* Bacon, Univ. Kansas Sci. Bull., vol. 38, pt. I, p. 787.

Winged female: Pronotum with apex acute, reaching first dorsal abdominal segment. Proportional length of dorsal abdominal segments (first to eighth):: 25: 50: 58: 59: 59: 61: 61: 51. First dorsal abdominal segment with posterior margin shallowly concave. Second dorsal abdominal segment with longitudinal carinae well defined, slightly divergent and dilated posteriorly; anteromesal impression obliterated; anterolateral and posterolateral impressions clearly separated from each other; intersegmental groove between second and third segments long and ill defined posteriorly, longitudinally rugose. Third segment with longitudinal carinae extend into intersegmental groove, with a shallow impression on either side of longitudinal carinae at apical end on each segment; intersegmental groove between third and fourth segments shorter than that between second and third segments, longitudinally rugose; disk on either side of longitudinal carinae obscurely transversely rugose. Seventh dorsal abdominal segment wider at base than long; seventh connexival segment with lateral margin rounded; seventh ventral abdominal segment with a row of black spines directed inwardly on posterior margin. Eighth with posterolateral margin broadly rounded, ventral side with a mass of black tubercles at sides. Metasternum behind transverse suture shortened medially.

Wingless female: Pronotum completely covers mesonotum, broadly rounded apically. Proportional length of dorsal abdominal segments (first to eighth):: 40: 49: 52: 54: 58: 62: 64: 53 (allotype). Anterior margin of first dorsal abdominal segment sinuate on either side of nearly straight and produced median area.

Winged male: Pronotum as in winged female. Proportional length of dorsal abdominal segments (first to seventh):: 25: 52: 55: 56: 56: 59: 74. Seventh dorsal abdominal segment simply widened posteriorly; lateral margin of seventh connexival segment with long hairs. Ventrolateral and dorsolateral margins of seventh and eighth abdominal segments with a row of black spines.

Wingless male: Pronotum completely covers mesonotum. Proportional length of dorsal abdominal segments (first to seventh):: 38: 47: 47: 43: 44: 49: 71 (holotype). Metasternum behind transverse suture strongly shortened medially, with distinctly elevated median longitudinal carina which extends down to sixth ventral abdominal segment. Dorsolateral and ventrolateral margins of seventh and eighth segments as in winged male.

Rhagovelia jubata Bacon

1948. *Rhagovelia jubata* Bacon, Jour. Kansas Ent. Soc., vol. 21, p. 78.

Winged female: Pronotum broadly rounded apically. Forewings with two basal cells white at base, then changes into orange, wing veins fuscous. With distinct longitudinal carinae on second and third dorsal abdominal segments. Seventh connexival segment narrowed posteriorly as in *Rh. horrida* or *Rh. crassipes,* with dark brown hairs near apex.

Since only the allomorphotype is winged the structure beneath the wing was not observed carefully. However, distinct carinae on second and third dorsal abdominal segments were clearly seen by lifting the wing.

Wingless female: Proportional length of dorsal abdominal segments (first to eighth):: 50: 46: 45: 43: 51: 54: 62: 82. Anterior margin of first dorsal abdominal segment rather strongly roundly produced.

Wingless male: Proportional length of dorsal abdominal segments (first to seventh):: 45: 48: 43: 44: 46: 50: 70. Connexivum rather strongly reflexed laterally. Venter with distinct longitudinal carina throughout metasternum behind transverse suture to sixth segment. Seventh ventral abdominal segment with minute black spines on posterolateral angle.

Rhagovelia nitida Bacon

(Pl. 10, figs. 35a, b)

1948. *Rhagovelia nitida* Bacon, Jour. Kansas Ent. Soc., vol. 21, p. 79.

Winged female: Pronotum at apex obtusely rounded, reaching the middle of second abdominal segment. Forewings nearly black, with two large apical cells. Proportional length of dorsal abdominal segments (first to eighth):: 22: 53: 50: 60: 63: 68: 73: 38. First dorsal abdominal segment with posterior margin broadly concave. Second dorsal abdominal segment with longitudinal carinae narrow but well-defined, rounded near base, usual three laevigate impressions clearly separated from each other, located on the depression continuous throughout along posterior margin of first segment and inner margin of second connexival segment; intersegmental groove short but well-defined, longitudinally rugose. Third segment with longitudinal carinae narrow but well-defined, divergent posteriorly, anteromesal impression small, depressed along posterior margin of third segment, anterolateral and posterolateral impressions subcontiguous; intersegmental groove between third and fourth segments short but well defined. Seventh dorsal abdominal segment elongate, narrowed apically, posterior margin sinuate; seventh connexival segment with lateral margin gently rounded and densely clothed with rather short hairs. Eighth segment about half as long as seventh segment on dorsal side, posterior margin nearly straight, with short hairs throughout. The last segment bent downward and invisible from above. Metasternum behind transverse suture inclined posteriorly and shortened medially.

Wingless female: Proportional length of dorsal abdominal segments (first to eighth):: 42: 42: 47: 51: 58: 60: 74: 48 (allotype). Ventral side of abdomen without median longitudinal carina. Connexivum feebly reflexed laterally.

Wingless male: Proportional length of dorsal abdominal segments (first to seventh):: 46: 44: 43: 44: 47: 49: 75 (holotype). Connexivum almost horizontally spread laterally. First dorsal abdominal segment roundly produced anteriorly. Metasternum behind transverse suture almost vertically inclined posteriorly. Basal ventral abdominal segments with distinct median longitudinal carina. Seventh and eighth ventral abdominal segments without a row of black spines on posterior margins.

This species is characterized by the following points:

(1) The last genital segment is bent downwardly and placed on the ventral surface of the eighth segment.

(2) The seventh dorsal abdominal segment almost twice as long as the eighth segment in winged females.

(3) The shape of the male clasper is much different from that of other species of the *crassipes* group.

(4) In the hind leg, the tibia is distinctly longer than the femur.

Rhagovelia ornata Bacon

1948. *Rhagovelia ornata* Bacon, Jour. Kansas Ent. Soc., vol. 21, p. 80.

Wingless male: Proportional length of dorsal abdominal segments (first to seventh):: 58: 62: 62: 62: 65: 69: 100. Metasternum behind transverse suture strongly shortened in the middle, inclined posteriorly, with median longitudinal elevation which extends down to basal ventral abdominal segments. Seventh ventral abdominal segment with posterior margin without black spines.

Wingless female: Proportional length of dorsal abdominal segments (first to eighth):: 60: 65: 72: 75: 80: 87: 97: 65 (paratype). Metasternum as in wingless male. Median longitudinal elevation on venter less pronounced than in male. Connexivum almost vertically reflexed.

Rhagovelia palea Bacon

(Pl. 9, figs. 31a, b)

1956. *Rhagovelia palea* Bacon, Univ. Kansas Sci. Bull., vol. 38, pt. I, p. 795.

Winged female: Pronotum with apex bluntly rounded, apical region sparsely clothed with long hairs. Forewings pale brown, veins white, with a wide white stripe on upper basal cell, with two large closed apical cells. Proportional length of dorsal abdominal segments (third to eighth):: 48: 50: 53: 57: 62: 55. First segment with median elevated area sinuate on posterior margin. Second segment with longitudinal carinae well defined, almost straightly divergent posteriorly; anteromesal impression obsolete, obscurely depressed along posterior margin of first segment on either side of carinae, anterolateral impression obliquely placed, posterolateral impression small, separated from anterolateral impression, but placed on the same shallow depression along inner margin of second connexival segment; intersegmental groove well defined, longitudinally rugose. Third dorsal abdominal segment with longitudinal carinae almost straightly divergent posteriorly; anteromesal impression well marked, depressed along posterior margin of second segment on either side of median longitudinal carinae, anterolateral and posterolateral impressions clearly separated from each other; intersegmental groove well defined and longitudinally rugulose. Seventh dorsal abdominal segment widened posteriorly, posterior margin sinuate, seventh connexival segment with inner margin sinuate, lateral margin rounded, clothed with long hairs. Eighth segment with posterior margin almost straight, posterolateral margin rounded; paratergite with fine hairs. The last genital segment small, rounded apically, clothed with fine hairs. Metasternum behind transverse suture inclined posteriorly, shortened medially.

Wingless female: Proportional length of dorsal abdominal segments (first to eighth):: 50: 42: 42: 43: 50: 54: 63: 56 (allotype). Connexivum reflexed laterally at angle of about forty-five degrees. First dorsal abdominal segment with long dark brown hairs directed posteriorly.

Wingless male: Pronotum entirely covers mesonotum. Proportional length of dorsal abdominal segments (first to seventh):: 40: 44: 35: 35: 35: 42: 75. Connexivum horizontally spread laterally. Metasternum behind transverse suture strongly inclined posteriorly, shorter in the middle. Venter with obscure median longitudinal elevation extending from base to sixth segment. Seventh ventral abdominal segment sparsely decorated with minute black spines on lateral area and along posterior margin at sides.

Rhagovelia perfidiosa Bacon

(Pl. 9, figs. 29a, b)

1948. *Rhagovelia perfidiosa* Bacon, Jour. Kansas Ent. Soc., vol. 21, p. 81.

Winged male: Pronotum with apex broadly rounded. Forewings pale fuscous, whitish at base, veins darker and thick, with two large apical cells. Proportional length of dorsal abdominal segments (second to seventh):: 32: 32: 32: 35: 35: 55. All dorsal abdominal segments are transverse. Second dorsal abdominal segment with longitudinal carinae slightly roundly widened at middle, finely longitudinally rugose along posterior margin of first dorsal abdominal segment throughout; anterolateral and posterolateral impressions clearly separated; intersegmental groove between second and third segments finely longitudinally rugulose. Third segment with longitudinal carinae less strongly rounded than in second segment; intersegmental groove between third and fourth segments finely longitudinally rugose; anterolateral and posterolateral impressions contiguous. Metasternum behind transverse suture inclined posteriorly, shortened in the middle. Seventh ventral abdominal segment with posterior margin without black minute spines. Median longitudinal elevation on ventral surface obscure.

Wingless male: Pronotum just reaching posterior margin of mesonotum. Proportional length of dorsal abdominal segments (first to seventh):: 32: 31: 28: 24: 25: 30: 52 (holotype). First dorsal abdominal segment with anterior margin slightly roundly produced. Ventral surface of body as in winged male.

Winged female: Proportional length of dorsal abdominal segments (fifth to eighth):: 36: 40: 48: 45. Seventh dorsal abdominal segment slightly widened posteriorly; seventh connexival segment with apex acutely pointed, reaching the middle of eighth abdominal segment, with a bundle of dark brown setae arising ventrally from near apex. Eighth segment with posterolateral margin broadly rounded. The last genital segment small, conical apically.

Wingless female: Proportional length of dorsal abdominal segments (first to eighth):: 37: 31: 32: 28: 33: 40: 50: 42. Connexivum subvertically erected. Metasternum behind transverse suture shorter than in male.

Rhagovelia relicta Gould

1931. *Rhagovelia relicta* Gould, Univ. Kansas Sci. Bull., vol. 20, p. 39.

Wingless male: Proportional length of dorsal abdominal segments (first to sixth):: 33: 40: 35: 35: 37: 40 (holotype). Ventral longitundinal ridge of abdomen obliterated.

Wingless female: Proportional length of dorsal abdominal segments (first to eighth):: 38: 45: 40: 39: 43: 48: 58: 50 (allotype). Connexivum vertically reflexed throughout.

Rhagovelia robusta Gould

1931. *Rhagovelia robusta* Gould, Univ. Kansas Sci. Bull., vol. 20, p. 41.

Wingless male: Proportional length of dorsal abdominal segments (first to seventh):: 41: 51: 48: 44: 45: 50: 71 (holotype). Metasternum behind transverse suture strongly inclined posteriorly, strongly shortened in the middle. Ventral abdominal segments strongly depressed laterally and with distinct median longitudinal carina from base down to sixth segment. Seventh ventral abdominal segment without black spines on posterior margin.

Wingless female: Proportional length of dorsal abdominal segments (first to eighth):: 40: 47: 45: 45: 51: 59: 64: 51 (allotype). Metasternum behind transverse suture strongly inclined posteriorly, shorter in the middle. Connexivum slightly reflexed.

Rhagovelia scitula Bacon

1956. *Rhagovelia scitula* Bacon, Univ. Kansas Sci. Bull., vol. 38, pt. I, p. 804.

Wingless male: Proportional length of dorsal abdominal segments (first to seventh):: 38: 45: 37: 38: 40: 44: 63. Metasternum behind transverse suture inclined posteriorly, shortened in the middle. Seventh ventral abdominal segment without black spines on posterior margin.

Wingless female: Proportional length of dorsal abdominal segments (first to eighth):: 40: 50: 45: 45: 52: 55: 72: 52. Metasternum as in wingless male.

Rhagovelia sinuata Gould

(Pl. 9, figs. 31a, b)

1931. *Rhagovelia sinuata* Gould, Univ. Kansas Sci. Bull., vol. 20, p. 42.

Winged female: Pronotum rounded apically. Forewings dark fuscous, lighter in upper basal cell, veins black. Proportional length of dorsal abdominal segments (second to eighth):: 55: 53: 55: 58: 62: 63: 55. First dorsal abdominal segment with median elevated area strongly sinuate on posterior margin; deeply depressed along posterior margin of first segment on either side of the carinae. Second segment with longitudinal carinae narrow but well marked, strongly divergent at base, then parallel-sided; posterolateral impression deep and well marked, distinctly separated from anterolateral impression; intersegmental groove between second and third segments shallow but well defined, longitudinally rugose. Third segment with longitudinal carinae divergent posteriorly; anteromesal impression shallow but distinct; anterolateral and posterolateral impressions are clearly separated; intersegmental groove shallow but well defined, longitudinally rugose, with a transverse shallow and distinct impression behind the posterior end of longitudinal carinae on third segment. Seventh dorsal abdominal segment slightly dilated at basal one third, distinctly wider at base than long in the middle, (90:63). Seventh connexival segment narrowed apically, its lateral margin rounded, apex acutely pointed and reaching the middle of eighth segment, apical margin sinuate. Eighth segment with apical margin broadly rounded, with a bundle of long brown hairs on the dorsal surface of eighth connexival segment. Metasternum behind transverse suture strongly inclined posteriorly, strongly and straightly narrowed medially. Ventral surface of abdomen without longitudinal carina.

Wingless female: Pronotum entirely covers mesonotum. Proportional length of dorsal abdominal segments (first to eighth):: 43: 53: 49: 53: 55: 60: 67: 57. Metasternum as in winged female.

Winged male: Pronotum broadly rounded on apical margin. Proportional length of dorsal abdominal segments (first to seventh):: 40: 50: 45: 43: 48: 52: 80. Metasternum as in winged female. Ventral side of abdomen without median longitudinal carina. Seventh segment without black spines on posterior margin.

Wingless male: Proportional length of dorsal abdominal segments (first to seventh):: 40: 50: 45: 43: 48: 52: 80. Metasternum and ventral side of abdomen as in winged male. Connexivum spread horizontally laterad.

Rhagovelia varipes Champion

(Pl. 10, figs. 32a, b)

1898. *Rhagovelia varipes* Champion, Biol. Centr. Amer., Het., vol. 2, p. 133.

Winged female: Pronotum broadly rounded apically. Forewings fuscous, veins black, with distinct two apical cells. Proportional length of dorsal abdominal segments (second to eighth):: 81: 80: 90: 87: 85: 87: 85. First dorsal abdominal segment with median elevated area posteriorly well defined and substraight. Second segment with median longitudinal carinae fine but well defined, feebly produced laterally at middle; anteromesal impression obliterated, obliquely depressed along posterior margin of first segment on either side of the carinae, posterolateral impression round, clearly separated from anterolateral impression; intersegmental groove obscurely defined and obscurely longitudinally rugulose. Third segment with longitudinal carinae feebly produced laterally at middle; anteromesal impression small and shallow; anterolateral and posterolateral impressions located on shallow depression along inner margin of third segment; intersegmental groove between third and fourth segments shallow, obscurely defined anteriorly. Seventh dorsal abdominal segment with posterior margin broadly sinuate; seventh connexival segment with lateral margin rounded, slightly narrowed posteriorly, apical margin sinuate. Eighth segment about as long as the preceding segment in the middle, posterior margin broadly rounded and densely clothed with long dark brown hairs, denser and longer laterally. The last genital segment small, rounded apically. Metasternum behind transverse suture strongly shortened in the middle, distinctly longitudinally carinate on basal two segments. Spiracle on seventh segment placed closer to posterior margin than to anterior margin.

Wingless female: Proportional length of dorsal abdominal segments (first to eighth):: 47: 72: 71: 76: 76: 81: 85: 70. Metasternum as in winged male. Fine median longitudinal carinae on venter as in winged female.

Winged male: Proportional length of dorsal abdominal segments (first to seventh):: 27: 75: 65: 73: 67: 67: 80. Metasternum as in winged female. Fine median longitudinal carina extends down to basal one fourth of fourth segment. Spiracle on seventh segment placed a little closer to anterior margin than to posterior margin. Seventh ventral abdominal segment without black spines on posterior margin.

Wingless male: Proportional length of dorsal abdominal segments (first to seventh):: 53: 85: 75: 65: 67: 65: 100. Connexivum vertically erected. Metasternum, ventral longitudinal carina and location of spiracles as in winged male.

Rhagovelia whitei (Breddin)

1898. *Rhagovelia whitei* Breddin, Jahrb. Nat. Ver. zu Magee, p. 14.

Wingless male: Proportional length of dorsal abdominal segments (first to seventh):: 35: 48: 43: 43: 48: 51: 68. Metasternum behind transverse suture inclined posteriorly. Median longitudinal ridge distinct down to sixth segment.

Wingless female: Proportional length of dorsal abdominal segments (first to eighth):: 35: 48: 43: 43: 48: 51: 57: 49. Connexivum reflexed at angle about forty-five degrees.

Rhagovelia williamsi Gould

1931. *Rhagovelia williamsi* Gould, Univ. Kansas Sci. Bull., vol. 20, p. 47.

Wingless male: Proportional length of dorsal abdominal segments (first to seventh):: 35: 48: 43: 43: 48: 51: 68. Metasternum behind transverse suture inclined posteriorly. Median longitudinal ridge distinct down to sixth segment.

Wingless female: Proportional length of dorsal abdominal segments (first to eighth):: 35: 48: 43: 43: 48: 51: 57: 49. Connexivum reflexed at angle of about forty-five degrees.

GROUP CHARACTERISTICS OF THE COLLARIS GROUP

The following species were available for the study of winged **forms:**

Rh. acuminata Bacon
Rh. armata (Burmeister)
Rh. collaris (Burmeister)
Rh. impensa Bacon
Rh. planipes Gould
Rh. scabra Bacon
Rh. tayloriella Kirkaldy

Longitudinal carinae fine and well defined, parallel-sided except for *Rh. collaris* and *Rh. tayloriella* in which the carinae are divergent posteriorly and tend to be obliterated.

Forewings with two large apical cells formed in distal half of the wing; subcosta extends apically as far as apical one fourth.

Pronotum in winged male develops into a long process; conspicuous projection at base of apical process directed downwardly.

Proportional length of sixth and seventh dorsal abdominal segments in winged male ranges from 44:70 in *Rh. collaris* to 80:92 in *Rh. scabra,* that in wingless male ranges from 58:85 in *Rh. solida* to

67:76 in *Rh. armata.* Proportional length of seventh and eighth dorsal abdominal segments ranges from 75:60 in *Rh. planipes* to 85:60 in *Rh. acuminata,* that in wingless female ranges from 88:98 in *Rh. scabra* to 82:59 in *Rh. planipes.*

The following characters are also peculiar to this group:

(1) In the intermediate leg the tibia is always more than twice as long as the second tarsal segment; third tarsal segment is always longer than the second one.

(2) In the hind leg the femur is considerably longer than the tibia except in *Rh. collaris* and *Rh. tayloriella* in which they are subequal to each other.

(3) The eighth segment with the paratergite in winged females with a bundle of hairs arising ventrally.

(4) The apex of the seventh connexival segment acutely produced except in *Rh. collaris* and *Rh. tayloriella.*

(5) In wingless females the dorsum of the abdomen is narrow.

(6) The intermediate femur of female is flattened beneath at base.

(7) The anterior tibia of the male is usually greatly dilated and excavated within.

Rh. collaris and *Rh. tayloriella* in common apparently deviate in some characters from other representatives of this group.

Rhagovelia acuminata Bacon

(Pl. 12, figs. 40a, b, c)

1956. *Rhagovelia acuminata* Bacon, Univ. Kansas Sci. Bull., vol. 38, pt. I, p. 817.

Winged male: Pronotum acutely pointed apically, obscure longitudinal carinae running in the middle throughout the entire length of pronotum. Forewings fuscous, veins thick and black. Proportional length of dorsal abdominal segments (first to seventh):: 23: 51: 68: 66: 70: 74: 92. First dorsal abdominal segment with median elevated area well defined laterally and posteriorly. Second segment with longitudinal carinae parallel-sided, thin, sparsely irregularly denticulated on lateral margin; anteromesal impression obsolete, anterolateral and posterolateral impressions shallow and clearly separated, shallowly depressed along posterior margin of first segment on either side of the carinae; intersegmental groove between second and third segments shallow. Third segment with longitudinal carinae feebly rounded at middle, extending posteriorly into intersegmental groove and black, lateral margin sparsely irregularly denticulated; anteromesal, anterolateral and posterolateral impressions shallow and separated from each other. Seventh dorsal abdominal segment strongly widened posteriorly; seventh connexival segment elongate subtriangular in shape, feebly rounded in the posterior half of lateral margin, its inner margin sinuate; posterior margin of seventh ventral segment straight in the middle, then oblique and slightly rounded laterally. Metasternum behind transverse suture inclined posteriorly, strongly shortened in the middle. Second ventral abdominal segment depressed. Ventral surface of abdomen obscurely longitudinally carinate in the middle from posterior region of metasternum to sixth segment. Seventh ventral abdominal segment with posterior margin armed with a series of small, black spines laterally.

Wingless male: Pronotum completely covering mesonotum. Proportional length of dorsal abdominal segments (first to seventh):: 36: 55: 58: 60: 70: 74: 93 (holotype). First dorsal abdominal segment with anterior margin gently roundly, produced anteriorly. Ventral surface of abdominal segments as in winged male.

Winged female: Pronotum produced posteriorly as a long process in female, this process is also provided with a projection at base and with a shallow cavity cephalad to it. Proportional length of dorsal abdominal segments (fourth to eighth):: 79: 85: 90: 85: 60. Seventh dorsal abdominal segment a little less than 1½ times as long as eighth segment; seventh connexival segment with lateral margin feebly rounded and narrowed posteriorly, with brown hairs throughout, these hairs become increasingly longer posteriorly; apex strongly acutely pointed and produced posteriorly, distinctly extending beyond posterior margin of eighth segment; posterior margin of seventh ventral abdominal segment feebly bisinuate. Eighth segment provided with a conspicuous bundle of long, black hairs arising from ventral side. Ventral side of abdomen without depression at base. Metasternum behind transverse suture lengthened at middle, posterior margin of metasternum bisinuate. Second and third ventral abdominal segments with median longitudinal elevation in anterior half. Seventh ventral abdominal segment with posterior margin with small black tubercles on either side of the base of ninth segment.

Wingless female: Proportional length of dorsal abdominal segments (first to seventh):: 43: 52: 64: 80: 91: 95(?): 75(?). Connexivum almost vertically reflexed throughout. Second dorsal abdominal segment strongly inclined posteriorly. First dorsal abdominal segment with anterior margin broadly rounded and produced anteriorly, clothed with long yellowish brown hairs directed posteriorly. Posterior margin of seventh ventral abdominal segment with a mass of black tubercles at sides.

Rhagovelia armata (Burmeister)

(Pl. 12, figs. 39a, b, c)

1835. *Velia armata* Burmeister, Handb. d. Ent., Bd. 2, p. 212.

Winged female: Pronotum develops posteriorly into a long process, directed upwards at the angle of forty-five degrees at base, then almost horizontally tapering into acute tip, with a light yellow process directed downward at base, this basal process is hollowed out on caudal side. Forewings purplish black, unicolorous, with two large apical cells. Proportional length of dorsal abdominal segments (first to eighth):: 27: 47: 64: 73: 80: 80: 77: 60. First dorsal abdominal segment with median elevated area straight and well defined posteriorly. Second dorsal abdominal segment with longitudinal carinae parallel-sided, lateral margin with irregular obscurely defined denticulations, depressed along posterior margin of first segment on either side of longitudinal carinae; anteromesal impression obsolete, anterolateral and posterolateral impressions distinct and large but separated from each other; intersegmental groove rather shallow, well-defined anteriorly and ill-defined posteriorly. Third segment with longitudinal carinae subparallel-sided, lateral margin with irregular, obscure denticulations; anteromedial impression well marked and black, anterolateral and posterolateral impressions subcontiguous; intersegmental groove between third and fourth segments black. Fifth to seventh dorsal abdominal segments each almost as long as wide. Seventh connexival segment acutely pointed, its apical margin sinuate, not reaching to the apex of eighth segment, posterior margin of seventh segment on ventral side feebly bisinuate; seventh ventral abdominal segment with posterior margin with a mass of few small, black tubercles at sides. Eighth connexival segment with a bundle of long, black hairs arising from ventral side. Last genital segment densely haired, gradually narrowed apically. Metasternum behind transverse suture lengthened at middle, posterior margin feebly bisinuate.

Wingless female: Proportional length of dorsal abdominal segments (first to eighth):: 42: 48: 52: 63: 80: 85: 88: 67. First dorsal abdominal segment with anterior margin broadly rounded and produced. Second and third segments inclined posteriorly. Fourth, fifth, and sixth segments roundly produced anteriorly. Connexivum almost vertically reflexed. Metasternum as in winged female. Seventh ventral abdominal segment with posterior margin armed with small black tubercles at sides.

Winged male: Metasternum behind transverse suture shortened in the middle, posterior margin broadly sinuate. Abdomen on ventral surface strongly depressed in basal region.

Wingless male: Proportional length of dorsal abdominal segments (first to seventh):: 40: 55: 52: 53: 56: 67: 76. Metasternum and seventh ventral abdominal segment as in winged male.

Rhagovelia collaris (Burmeister)

(Pl. 11, figs. 37a, b, c)

1835. *Velia collaris* Burmeister, Handb. d. Ent., Bd. 2, p. 212.

Winged female: Pronotum with apical process rather thick, directed upwardly at the angle of about forty-five degrees, then directed slightly downward; the process at base of apical process small and rounded. Forewings dark fuscous brown, veins black, with two large apical cells. Proportional length of dorsal abdominal segments (first to eighth):: 23: 38: 47: 47: 50: 52: 63: 50. First dorsal abdominal segment well defined posteriorly. Second segment with longitudinal carinae roundly divergent posteriorly; anteromesal impression distinct, anterolateral and posterolateral impressions subcontiguous, distinctly depressed along posterior margin of first segment on either side of carinae, the area within the carinae transverse; intersegmental groove distinctly impressed, well defined anteriorly, obscurely defined posteriorly. Third segment with longitudinal carinae divergent posteriorly, not quite reaching posterior margin of the segment; anteromesal impression small, anterolateral and posterolateral impressions continuous. Seventh segment wider at base than it is long at middle (90:63); seventh connexival segment narrowed apically, its lateral margin broadly rounded, apex acutely rounded; posterior margin of seventh ventral abdominal segment bisinuate, densely pubescent throughout. Eighth segment purplish black except for the middle yellow; lateral margin of eighth connexival segment almost straight, with a bundle of long dark brown hairs arising mainly from the ventral side, posterior margin of eighth dorsal abdominal segment broadly rounded. The last genital segment subparallel, narrowed apically, downward and densely clothed with dark hairs especially on lateral margin. Metasternum behind transverse suture short, posterior margin broadly sinuate and shortened in the middle.

Wingless female: Connexivum strongly reflexed and folded on the dorsum completely after second segment.

Winged male: Pronotum simply and acutely pointed. Proportional length of dorsal abdominal segments (first to seventh):: 25: 38: 41: 42: 42: 44: 70. Metasternum behind transverse suture and basal two ventral abdominal segments depressed, posterior margin of metasternum more strongly sinuate than in female. Obscure longitudinal carinae running in the middle of metasternum behind transverse suture and second to sixth ventral abdominal segments.

Wingless male: Proportional length of dorsal abdominal segments (first to seventh):: 45: 48: 48: 46: 47: 53: 77 (paratype). Metasternum as in winged male.

This species is different from *Rh. armata* (Burmeister) as follows:

(1) The longitudinal carinae are strongly divergent posteriorly, and tend to be obliterated apically on the third segment.

(2) The last female genital segment is strongly bent downward.

(3) The posterior margin of the seventh connexival segment is rounded.

Rhagovelia impensa Bacon

(Pl. 11, figs. 38a, b, c)

1956. *Rhagovelia impensa* Bacon, Univ. Kansas Sci. Bull., vol. 38, pt. I, p. 827.

Winged male: Pronotum narrow and acutely pointed at apex. Forewings dark fuscous, veins black, with two large apical cells. Proportional length of dorsal abdominal segments (first to seventh):: 25: 42: 50: 55: 58: 60: 75. Second segment with longitudinal carinae slightly divergent posteriorly, with obscure denticulation on lateral margin; anteromesal impression obsolete, lateral impressions small, clearly separated, hardly depressed along posterior margin of first segment, shallowly depressed along inner margin of second connexival segment; intersegmental groove well defined anteriorly, obscurely defined posteriorly. Third segment with longitudinal carinae subparallel-sided, slightly divergent posteriorly; anteromesal impression obliterated; anterolateral and posterolateral impressions separated, depressed along inner margin of third connexival segment; intersegmental groove distinct anteriorly, obscure on posterior margin. Metasternum behind transverse suture and basal two ventral abdominal segments strongly depressed and with median longitudinal carinae; transverse suture on metasternum straight, posterior margin of metasternum broadly roundly emarginated. Posterior margin of seventh ventral abdominal segment with a series of minute black spines.

Wingless male: Proportional length of dorsal abdominal segments (first to seventh):: 35: 43: 44: 43: 47: 53: 80. Ventral side of the body as in winged male.

Winged female: Pronotum with lower margin of apical process roundly continuous with posterior margin of basal process, lower margin of basal process rather weakly developed, apex of apical process densely clothed with long hairs. Seventh dorsal abdominal segment as long in the middle as wide at base; seventh connexival segment reflexed laterally in apical half, acutely pointed. Eighth segment about three-fourths as long as preceding segment, posterior margin broadly rounded; paratergite produced laterally at basal one third; disk of eighth segment with a pair of round cavities on basal margin, apical half and the last genital segment strongly directed downwardly. Lateral margin of the last genital segment clothed with short but strong black hairs. Metasternum behind transverse suture not inclined posteriorly, subequal in length throughout except for leg base. Seventh ventral abdominal segment with posterior margin with black tubercles at sides. Eighth ventral abdominal segment with posterior margin with a series of minute black spines directed inwardly.

Wingless female: Proportional length of dorsal abdominal segments (first to sixth):: 40: 45: 45: 41: 55: 68. Connexivum strongly reflexed, at more than ninety degrees after third segment. Posterior margin on ventral side as in winged female.

Rhagovelia planipes Gould

(Pl. 12, figs. 41a, b, c)

1931. *Rhagovelia collaris planipes* Gould, Univ. Kansas Sci. Bull., vol. 20, p. 22.

Winged female: Pronotum with apical area strongly almost horizontally produced posteriorly as a process, with a well-developed basal process directed downward. Forewings fuscous, upper basal cell whitish, veins black, with two large apical cells. Proportional length of dorsal abdominal segments (first to eighth):: 27: 52: 63: 73: 73: 80: 75: 60. Second dorsal abdominal segment with longitudinal carinae straight and slightly divergent posteriorly; obscurely grooved along posterior margin of first dorsal abdominal segment; anteromesal impression small and round, anterolateral and posterolateral impressions clearly separated; intersegmental groove well defined and with obscure oblique elevations. Third segment with longitudinal carinae parallel-sided, extending slightly into fourth dorsal abdominal segment; anteromesal impression small and round, depressed along posterior margin of second segment on either side of longitudinal carinae; anteromesal impression small and round, anterolateral and posterolateral impressions separated from each other; intersegmental groove between third and fourth segments rather obscurely defined. Seventh dorsal abdominal segment a little wider than long at middle (90:75); seventh connexival segment gradually narrowed apically, apex acutely pointed and black, reaching posterior margin of eighth segment. Eighth segment with posterior margin broadly rounded; paratergite slightly elevated. Metasternum behind transverse suture short and slightly longer near leg base. Posterior margin of seventh ventral abdominal segment with several small black teeth laterally.

Wingless female: Proportional length of dorsal abdominal segments (second to eighth):: 58: 58: 62: 78: 80: 82: 59. Second and third dorsal abdominal segments inclined posteriorly. Connexivum reflexed at the angle a little less than ninety degrees. Metasternum as in winged female.

Winged male: Pronotum narrowed apically and acutely pointed. All dorsal abdominal segments transverse. Proportional length of dorsal abdominal segments (fifth to seventh):: 58: 58: 89. Seventh dorsal abdominal segment strongly widened posteriorly; seventh connexival segment subtriangular and relatively short; seventh ventral abdominal segment with posterior margin deeply sinuate, with small, black teeth laterally. Metasternum behind transverse suture strongly inclined posteriorly, posterior margin broadly roundly sinuate, shorter in the middle. Ventral surface of abdomen depressed and with longitudinal carinae in the middle.

Wingless male: Proportional length of dorsal abdominal segments (first to seventh):: 45: 55: 55: 52: 52: 65: 82. Metasternum behind transverse suture as in winged form.

Rhagovelia scabra Bacon

(Pl. 8, fig. 24)

1956. *Rhagovelia scabra* Bacon, Univ. Kansas Sci. Bull., vol. 38, pt. I, p. 831.

Winged male: Pronotum narrowed apically, acutely pointed. Wings purplish fuscous, veins black, with two large apical cells. Proportional length of dorsal abdominal segments (first to seventh):: 30: 57: 71: 78: 73: 80: 92. First dorsal abdominal segment with posterior margin on either side of median elevation obliterated.

Second dorsal abdominal segment with longitudinal carinae subparallel except at base slightly divergent, narrow, well-defined; anteromesal impression obliterated, anterolateral and posterolateral impressions clearly separated, slightly depressed along inner margin of second connexival segment; intersegmental groove between second and third segments well defined anteriorly, obscurely defined posteriorly. Third segment with longitudinal carinae narrow, subparallel except in intersegmental region; anteromesal impression obliterated, anterolateral and posterolateral impressions separated, depressed along inner margin of third connexival segment; intersegmental groove well defined anteriorly. Metasternum with transverse suture straight, metasternum behind transverse suture broadly sinuate on posterior margin and shorter in the middle, strongly depressed. Second and third ventral abdominal segments strongly depressed. Posterior margin of seventh ventral abdominal segment broadly roundly emarginated, with a series of small black teeth on either side of the middle.

Wingless male: Proportional length of dorsal abdominal segments (first to seventh):: 37: 62: 55: 55: 57: 63: 80 (holotype). Metasternum and ventral side of abdomen as in winged male.

Wingless female: Proportional length of dorsal abdominal segments (first to eighth):: 42: 60: 65: 67: 88: 88: 98: 70. Second and third dorsal abdominal segments strongly inclined posteriorly, apical half of seventh and basal half of eighth dorsal abdominal segments clothed with long black hairs. Metasternum with transverse suture straight, posterior margin of metasternum feebly bisinuate. Connexivum reflexed at more than ninety degrees after third segment.

Rhagovelia solida Bacon

1956. *Rhagovelia solida* Bacon, Univ. Kansas Sci. Bull., vol. 38, pt. I, p. 833.

Wingless male: Proportional length of dorsal abdominal segments (first to seventh):: 47: 55: 54: 54: 54: 58: 85 (holotype). First dorsal abdominal segment broadly rounded and slightly produced. Metasternum behind transverse suture inclined posteriorly, strongly shortened in the middle. Seventh ventral abdominal segment with posterior margin armed with a series of minute black spines laterally, deeply sinuate.

Wingless female: Proportional length of dorsal abdominal segments (first to fifth):: 55: 62: 57: 78: 87 (allotype). Connexivum reflexed at the angle more than ninety degrees after third segment.

Third segment inclined posteriorly. Metasternum behind transverse suture level.

Rhagovelia tayloriella Kirkaldy

(Pl. 11, figs. 36a, b, c)

1900. *Rhagovelia tayloriella* Kirkaldy, Ent., vol. 33, p. 72.

Winged female: Pronotum with apical process rather short, robust, raised upwardly at the angle a little less than forty-five degrees, with a weakly developed process at base of apical process. Forewings with a greenish tinge along the upper margin in basal half. Second dorsal abdominal segment with longitudinal carinae roundly divergent towards middle; anteromesal impression obsolete, anterolateral and posterolateral impressions clearly separated, shallowly depressed along posterior margin of first dorsal abdominal segment on either side of carinae, anterolateral and posterolateral impressions clearly separated; intersegmental groove between second and third segments strongly produced and lengthened anteriorly at middle. Third segment with longitudinal carinae less distinct than those on second segment, but reaching posterior margin of third segment, slightly divergent posteriorly; anteromesal laevigate impression obsolete, instead distinctly depressed along posterior margin of second dorsal abdominal segment on either side of longitudinal carinae, distinctly depressed along inner margin of third connexival segment, anterolateral and posterolateral impressions separated. Disk bounded laterally by longitudinal carinae, transverse in both second and third segments; intersegmental groove between third and fourth segments distinct. Seventh dorsal abdominal segment about as long as wide at base; seventh connexival segment slightly narrowed posteriorly, apex narrowly rounded and produced, thickly clothed with long dark brown hairs; seventh ventral abdominal segment with posterior margin feebly bisinuate. Eighth segment with posterior margin broadly rounded; paratergite in basal half strongly reflexed, with a bundle of long, dark brown hairs arising from ventral side. The last genital segment inclined posteriorly, densely clothed with short hairs. Metasternum behind transverse suture shorter at middle, depressed and with median longitudinal carina. Second ventral abdominal segment depressed and with median longitudinal carina which is continuous with that on metasternum.

Wingless female: Proportional length of dorsal abdominal segments (first to eighth):: 42: 42: 42: 46: 47: 63: 77: 55. Third segment inclined posteriorly, fifth to seventh segments each longer than wide, posterior margin of seventh dorsal abdominal segment densely clothed with long, black hairs. Connexivum reflexed at about right angle. Metasternum behind transverse suture subequal in length throughout, slightly shorter at middle. Seventh ventral abdominal segment with posterior margin feebly bisinuate. Last genital segment bent downward.

Winged male: Proportional length between sixth and seventh segment:: 55: 70.

Wingless male: Proportional length of dorsal abdominal segments (first to seventh):: 35: 43: 41: 41: 45: 48: 70. Seventh ventral abdominal segment without a series of black spines on posterior margin.

Remarks: This species has characteristics in common with *Rh. collaris* (Burmeister) as follows:

(1) The area bounded laterally by longitudinal carinae on the second and third dorsal abdominal segments distinctly wider than long.

(2) The male without a series of black spines on the posterior margin of the seventh ventral abdominal segment.

(3) The hind femur and tibia are subequal in length.

(4) The last genital segment is strongly bent downward.

(5) The apex of the seventh connexival segment is not acutely produced.

Group Characteristics of the Obesa Group

The following three species were available for the study of winged forms: *Rh. distincta* Champion, *Rh. obesa* Uhler, and *Rh. rivale* Bueno.

Pronotum in winged female with short and thick process apically; pronotum in wingless forms rather short except for *Rh. oriander.*

Forewings with two large apical cells formed in distal half of the wing.

Longitudinal carinae occur always on second and third dorsal abdominal segments in winged forms.

Proportional length of sixth and seventh dorsal abdominal segments is about 2:3 in winged male of *Rh. distincta* and *Rh. rivale;* that of wingless male ranges from 40:77 in *Rh. obesa* to 46:75 in *Rh. distincta.* Proportional length of seventh and eighth segments in winged female is 82:60 in *Rh. distincta* and 55:45 in *Rh. obesa,* that in wingless female is 110:78 in *Rh. distincta.*

The following characters are also peculiar to this group.

(1) The lateral margin of the seventh connexival segment in winged females sinuate.

(2) The posterior margin of the seventh ventral abdominal segment with a series of minute black spines, except in *Rh. rivale.*

(3) The eighth segment has a conspicuous bundle of long setae arising ventrally near the lateral margin in the female.

(4) The intermediate femur is dorsoventrally flattened in the female.

(5) The hind femur is distinctly longer than the tibia except in *Rh. rivale,* in which they are subequal to each other.

(6) The anterior tibia is never greatly dilated or excavated beneath in the male.

As noted from the above *Rh. rivale* deviates distinctly from other representatives of this group at least in two characters. These two characters, *i. e.,* the proportional length of the hind femur and tibia and the absence of black spines on posterior margin of seventh ventral abdominal segment are characters shared by *Rh. collaris* and *Rh. tayloriella* of the *collaris* group. *Rh. rivale,* however, is definitely a member of this group in the structure of the anterior tibia upon which Bacon's classification is based.

Rhagovelia distincta Champion

(Pl. 13, figs. 42a, b, c)

1877. *Rhagovelia mexicana* Signoret, Bull. Soc. Ent. Fr. (5): 7: p. 53 (no description).

1898. *Rhagovelia distincta* Champion, Biol. Centr. Amer., Het., vol. 2, p. 135.

Winged female: Pronotum with apical process rather short and thick, clothed with short black hairs, raised upward at an angle a little less than forty-five degrees, upper margin of apex almost horizontal, basal process weakly developed. Forewings dark fuscous, with greenish tinge on upper basal cell, veins black, two large apical cells formed in distal half. Proportional length of dorsal abdominal segments (second to eighth):: 50: 50: 55: 59: 63: 82: 60. Longitudinal carinae on second dorsal abdominal segment slightly divergent posteriorly, anteromesal impression obliterated, anterolateral and posterolateral impressions clearly separated from each other; intersegmental groove between second and third segments shallow but long, with obscure longitudinal elevation. Third segment with longitudinal carinae slightly divergent posteriorly, extend slightly beyond intersegmental groove apically in one specimen examined; anterolateral and posterolateral impressions clearly separated from each other; intersegmental groove between third and fourth segments shorter, obscurely longitudinally rugose. Seventh dorsal abdominal segment a little longer in middle than basal width (82:75); seventh connexival segment narrowed apically, apex narrowly rounded, reaching the middle of eighth segment; seventh ventral abdominal segment feebly bisinuate at middle on posterior margin. Eighth dorsal abdominal segment with apical margin broadly rounded; paratergite ill defined posteriorly, with a bundle of long black setae arising from ventral surface. Last genital segment short. Metasternum behind transverse suture level, short, subequal in length throughout.

Wingless female: Proportional length of dorsal abdominal segments (first to seventh):: 42: 50: 57: 71: 90: 110: 78. Connexivum behind third segment folded on dorsum. Third dorsal abdominal segment not strongly inclined posteriorly.

Winged male: Proportional length of dorsal abdominal segments (first to seventh):: 28: 43: 50: 45: 45: 50: 72. Metasternum behind transverse suture inclined posteriorly, shortened medially. Seventh ventral abdominal segment with posterior margin armed with a series of minute black spines.

Wingless male: Mesonotum slightly exposed behind pronotum. Proportional length of dorsal abdominal segments (first to seventh):: 37: 45: 43: 41: 41: 46: 75. Metasternum behind transverse suture inclined posteriorly.

Rhagovelia knighti Drake and Harris

1927. *Rhagovelia knighti* Drake and Harris, Proc. Biol. Soc. Washington, vol. 40, p. 133.

Wingless male: Proportional length of dorsal abdominal segments (first to seventh):: 29: 34: 31: 30: 30: 36: 67 (paratype). Third dorsal abdominal segment not inclined posteriorly. Metasternum behind tranverse suture rather strongly shortened in the middle. Seventh ventral abdominal segment with posterior margin armed with a series of black spines laterally.

Wingless female: Proportional length of dorsal abdominal segments (second to eighth):: 30: 33: 34: 29: 38: 47: 75. Connexivum strongly reflexed and folded on the dorsum. Metasternum behind transverse suture short, subequal in length throughout except for near leg base slightly longer.

Rhagovelia obesa Uhler

(Pl. 13, figs. 44a, b, c)

1871. *Rhagovelia obesa* Uhler, Proc. Bost. Soc. Nat. Hist., vol. 14, p. 107.

Winged female: Pronotum with apex produced posteriorly as a thick process, and dilate apex notched on apical margin. Forewings fuscous, veins black, with two large apical cells. Proportional length of dorsal abdominal segments (first to eighth):: 22: 35: 32: 33: 40: 43: 55: 45. Second dorsal abdominal segment with longitudinal carinae straight, slightly convergent posteriorly; anteromesal impression obsolete, anterolateral and posterolateral impressions small and clearly separated; intersegmental groove between second and third segments rather obscure. Third segment with longitudinal carinae straight, subparallel; anterolateral and posterolateral impressions subcontiguous; intersegmental groove short, obscurely longitudinally rugose. Seventh dorsal abdominal segment longer at middle than basal width (55:50); seventh connexival segment with lateral margin sinuate in apical half, apex narrowly rounded and with short, black hairs. Eighth dorsal abdominal segment with paratergite strongly reflexed, with a bundle of long and black setae, posterior margin of eighth segment almost straight, posterolateral angle broadly rounded. The last genital segment gradually narrowed apically, apical margin rounded. Metasternum behind transverse suture short and level.

Wingless female: Mesonotum well exposed posteriorly, posterior margin of pronotum feebly sinuate. Proportional length of dorsal abdominal segments (first to sixth):: 32: 32: 32: 28: 32: 47. Connexivum strongly reflexed and the dorsum narrowly exposed. Second and third segments slightly inclined posteriorly. Metasternum behind transverse suture short, slightly lengthened at middle.

Wingless male: Pronotum short. Mesonotum widely exposed posteriorly. Proportional length of dorsal abdominal segments (first to seventh):: 28: 32: 32: 32: 35: 40: 77. Metasternum behind transverse suture inclined posteriorly, shorter in the middle. Seventh ventral abdominal segment with posterior margin armed with a few black spines laterally.

Rhagovelia oriander Parshley

(Pl. 10, fig. 34)

1922. *Rhagovelia oriander* Parshley, South Dakota State Ent. Tech. Bull., vol. 2, p. 19.

Wingless male: Pronotum with apex obtusely pointed, extending slightly beyond posterior margin of mesonotum, but posterolateral portion of the latter well exposed. Proportional length of dorsal abdominal segments (first to seventh):: 30: 34: 32: 30: 31: 34: 65. Metasternum behind transverse suture short, shortest in the middle. Posterior margin of seventh ventral abdominal segment with a series of black spines laterally.

Wingless female: Pronotum produced as a thick process, with weakly developed basal process. Connexivum strongly reflexed and folded on dorsum for apical four segments. Metasternum behind transverse suture subequal in length throughout, short.

Rhagovelia rivale Bueno

(Pl. 13, figs. 43a, b, c)

1924. *Rhagovelia rivale* Torre-Bueno, Trans. Amer. Ent. Soc., vol. 50, p. 247.

Winged male: Pronotum acutely pointed and raised apically. Forewings fuscous, yellowish along lower margin, veins black, with two well-defined apical cells. Proportional length of dorsal abdominal segments (first to seventh):: 25: 38: 35: 34: 34: 40: 60. Second segment with longitudinal carinae roundly divergent posteriorly; anteromesal, anterolateral and posterolateral impressions separated from each other, but located within the continuous groove along anterior and lateral margins of second segment; intersegmental groove between second and third segments short but rather deep, longitudinally rugose. Third segment with longitudinal carinae divergent posteriorly, anterolateral and posterolateral impressions subcontiguous; intersegmental groove between third and fourth segments deep but short. Metasternum behind transverse suture shorter at middle, posterior margin sinuate. Seventh ventral abdominal segment without black spines.

Wingless male: Pronotum with apical margin feebly produced posteriorly in the middle. Proportional length of dorsal abdominal segments (first to eighth):: 27: 32: 30: 30: 30: 38: 58: 51. Metasternum behind transverse suture short, subequal in length throughout.

Winged female: Pronotum with apical process rather short, strongly dilated apically, clothed with long dark hairs on apical margin. Seventh dorsal abdominal segment a little longer in the middle than basal width; seventh connexival segment with lateral margin slightly sinuate in apical half, apex acutely pointed and directed slightly laterad and with a few black, short but stiff hairs, inner margin bisinuate. Eighth segment broad, apical margin broadly rounded. The last genital segment directed slightly downward, densely clothed with black hairs. Metasternum behind transverse suture short, subequal in length throughout.

Wingless female: Posterior margin of pronotum broadly rounded. Mesonotum broadly exposed behind pronotum. Proportional length of dorsal abdominal segments (first to eighth):: 37: 45: 42: 43: 46: 52: 68: 58. Connexivum strongly reflexed and almost folded on the dorsum after fourth segment. Metasternum behind transverse suture subequal in length throughout except for near leg base where it is a little longer.

GROUP CHARACTERISTICS OF THE AINSLEI GROUP

All three species belonging to this group were available for the study of winged forms.

Distinct longitudinal carinae in basal dorsal abdominal segments always occur on the second and third segments. The carinae also occur on the fourth segment in male *Rh. ainslei.* First dorsal abdominal segment with the median elevated area rather narrow. Forewings always with two long apical cells formed beyond the basal half of the wing; subcosta develops as far as apical one fourth of the wing. Pronotum of winged forms broadly rounded apically, completely covering the mesonotum beneath, uppersurface of pronotum with median longitudinal ridge running throughout the entire length and with rather large impressions scattered on the surface.

The following characters are also peculiar to this group.

(1) The dorsum of the abdomen is narrowed after the first three segments.

(2) The seventh connexival segment in female forms is a small triangular cell between the lateral margins of eighth segment.

(3) The eighth segment in the female has a bundle of black setae directed more or less downward.

(4) The male in both winged and wingless forms is strongly depressed in the basal ventral abdominal segments.

(5) The seventh ventral abdominal segment with a series of minute black spines directed inwardly.

(6) The intermediate femur of the female is dorsoventrally flattened.

(7) The intermediate tibia is less than twice as long as the second tarsal segment.

(8) The second and third tarsal segments in the intermediate legs are equal or subequal to each other in length.

(9) The hind femur is longer than the tibia, except in *Rh. ainslei.*

(10) The terminal genital segment is prolonged into a sharply pointed process in both sexes.

KEY TO THE WINGED FORMS OF THE SPECIES OF THE AINSLEI GROUP

1. Hind femur shorter than tibia. Distinct longitudinal carinae occur on the fourth segment at least in male. Apex of seventh connexival segment in female rounded . . . . *Rh. ainslei*

1'. Hind femur longer than tibia. Without distinct longitudinal carinae on the fourth segment. Apex of seventh connexival segment in female acutely pointed 2

2. Pronotum in female with the apical process vertically erected at base. Longitudinal carinae on the basal abdominal segments convergent posteriorly. Seventh connexival segment in female reflexed and produced above the eighth segment . . . . *Rh. becki*

2'. Pronotum in female with the apical process subhorizontally produced posteriorly. Longitudinal carinae divergent posteriorly. Seventh connexival segment not reflexed . . . . *Rh. gracilis*

Rhagovelia becki Drake and Harris

(Pl. 14, figs. 47a, b, c)

1936. *Rhagovelia becki* Drake and Harris, Proc. Biol. Soc. Washington, vol. 49, p. 106.

Winged female: Pronotum with a black low longitudinal ridge running from anterior margin to apex, apical processlike projection almost vertically erected at base, then bent posteriorly at about forty-five degrees, extreme apex narrowly rounded. Forewings fuscous, with greenish tinge at base, veins darker. Proportional length of dorsal abdominal segments (second to eighth):: 42: 49: 57: 65: 72: 78: 54. Second dorsal abdominal segment with longitudinal carinae divergent at base, then slightly convergent posteriorly as far as posterior margin, obscurely grooved and with obscure longitudinal elevation along median elevated portion of first segment; anteromesal impression obliquely placed along longitudinal carinae at base, anterolateral and posterolateral impressions clearly separated from each other. Third dorsal abdominal segment with longitudinal carinae slightly convergent posteriorly; intersegmental groove between second and third segments obscurely longitudinally rugulose; anteromesal and anterolateral impressions contiguous, posterolateral impression obliterated. Fifth and sixth segments longer than wide. Seventh segment with posterior margin feebly sinuate; seventh connexival segment narrowed apically, reflexed and produced above eighth segment, apex acutely pointed and with short black hairs. Eighth dorsal abdominal segment with apical margin broadly rounded, with a conspicuous bundle of black setae arising ventrally. The last genital segment rather acutely pointed at apex, densely clothed with short black hairs. Metasternum behind transverse suture subequal in length throughout.

Wingless female: Pronotum with apex broadly rounded, without longitudinal ridge. Connexivum subvertically reflexed throughout. Proportional length of dorsal abdominal segments (first to eighth):: 38: 45: 45: 50: 65: 76: 92: 58. Posterior margin of seventh dorsal abdominal segment densely clothed with long and black setae. Metasternum as in winged female.

Winged male: Apical process of pronotum as in winged female, but much less strongly developed. Connexivum strongly reflexed. Eighth dorsal abdominal segment thick and long, densely clothed with white hairs, subparallel-sided, slightly dilated apically. Metasternum behind transverse suture and second ventral abdominal segment depressed and with median longitudinal elevation, posterior margin of metasternum subangularly emarginated in the middle.

Wingless female: Pronotum with apex rounded, completely covers mesonotum. Proportional length of dorsal abdominal segments (first to seventh):: 35: 38: 37: 37: 42: 53: 83. Seventh ventral abdominal segment with posterior margin armed with minute black spines directed inwardly.

Rhagovelia gracilis Bacon

(Pl. 14, figs. 46a, b, c)

1956. *Rhagovelia gracilis* Bacon, Univ. Kansas Sci. Bull., vol. 38, pt. I, p. 861.

Winged female: Pronotum with a low black ridge from anterior margin to apex; apex developed into a long simple process clothed with long black hairs. Forewings with two distinct long closed cells, fuscous, veins darker. Proportional length of dorsal abdominal segments (fourth to eighth):: 42: 56: 55: 63: 42. First segment with median elevation rather narrow. Second segment with longitudinal carinae well marked, roundly strongly divergent posteriorly; anteromesal impression obliterated, anterolateral and posterolateral impressions separated; intersegmental groove between second and third segments well defined but rather shallow. Third segment with longitudinal carinae strongly divergent posteriorly; anteromesal impression obliterated, anterolateral and posterolateral impressions reduced and continuous; intersegmental groove between third and fourth segments ill defined posteriorly. All dorsal abdominal segments transverse. Seventh connexival segment strongly narrowed in apical half, inner margin sinuate, apex acutely pointed and reflexed with short black hairs. Eighth segment with paratergite ill defined posteriorly, posterolateral margin of eighth dorsal abdominal segment broadly rounded, with a bundle of long, black bristles directed downward. The last genital segment subtriangular, clothed with fine long hairs. Metasternum behind transverse suture short, slightly lengthened laterally.

Wingless female: Pronotum with a black longitudinal low ridge reaching near to apex which completely covers mesonotum. Proportional length of dorsal abdominal segments (first to eighth):: 40: 42: 41: 41: 56: 71: 92: 53. Metasternum behind transverse suture lengthened laterally. Connexivum strongly reflexed and folded on the dorsum in the middle.

Winged male: Pronotum with apex acutely pointed and slightly produced posteriorly. Proportional length of dorsal abdominal segments (first to seventh):: 22: 32: 35: 40: 42: 45: 70. First to sixth dorsal abdominal segments transverse. Metasternum behind transverse suture and basal two ventral abdominal segments depressed and with median longitudinal carinae. Seventh ventral abdominal segment with a series of black minute spines directed inward at sides.

Wingless male: Proportional length of dorsal abdominal segments (first to seventh):: 30: 34: 36: 36: 43: 51: 80 (holotype). Metasternum behind transverse suture and two basal ventral abdominal segments strongly depressed, with distinct median longitudinal elevation.

Rhagovelia ainslei Drake and Harris

(Pl. 14, figs. 45a, b, c)

1933. *Rhagovelia ainslei* Drake and Harris, Proc. Biol. Soc. Washington, vol. 46, p. 50.

Winged male: Pronotum with distinct black median longitudinal ridge running throughout the entire length of pronotum, apical process weakly developed. Forewings with two distinct closed cells, fuscous; veins darker. Proportional length of dorsal abdominal segments (second to seventh):: 35: 35: 38: 38: 43: 65. Connexivum vertically erected throughout. First dorsal abdominal segment with median elevated area well-defined, but comparatively narrow. Second dorsal abdominal segment with longitudinal carinae thick, rather strongly divergent at base; anteromesal impression small, anterolateral and posterolateral impressions contiguous; intersegmental groove between second and third segments shallow. Third segment with longitudinal carinae roundly divergent in anterior half then converge posteriorly; anteromesal impression distinct, anterolateral and posterolateral impressions contiguous; intersegmental groove between third and fourth segments distinct and well defined. Fourth segment with distinct though less well marked longitudinal carinae almost reaching to posterior margin of the same segment, this carina is not developed in one female examined. Eighth segment thick and subparallel. Seventh ventral abdominal segment with posterior margin armed with a series of minute black spines directed inward at sides.

Wingless male: Proportional length of dorsal abdominal segments (first to seventh):: 28: 31: 25: 30: 31: 40: 65. Connexivum vertically reflexed. Anterior margin of first dorsal abdominal segment straight. Eighth segment thick, parallel-sided. Metasternum behind transverse suture subvertically inclined posteriorly, shortened in the middle. Second to fourth segments depressed and with median longitudinal ridge.

Winged female: Pronotum with a black median longitudinal ridge throughout the entire length, apex strongly developed subhorizontally as a long process and clothed with long, dark hairs. Forewings fuscous, veins darker. Connexivum less strongly reflexed than in male. Seventh dorsal abdominal segment a little wider at base than it is long in the middle; seventh connexival segment slightly narrowed apically, posterior margin broadly rounded, forming a small transverse, subtriangular plate between lateral margin of eighth segment. Eighth connexival segment with inner margin obliterated posteriorly, with a bundle of black setae arising ventrally. Metasternum behind transverse suture plane, shortened medially.

GROUP CHARACTERISTICS OF THE SPINIGERA GROUP

All four species treated by Bacon were available for the study of winged forms.

Pronotum in winged male acute at tip, strongly produced as process apically in winged female.

Forewings always dark fuscous and with greenish tinge in basal half, with two large apical cells formed in distal half.

Longitudinal carinae always occur on second and third abdominal segments; the carinae are also poorly developed on the fourth segment (*Rh. spinigera* and *Rh. ignota*). First dorsal abdominal segment with the median elevated area well defined both laterally and posteriorly. Second segment always with well-defined laevigate depression along the posterior margin of first segment; posterolateral laevigate impression is clearly separated from anterolateral impression.

Proportional length between sixth and seventh dorsal abdominal segments in winged male ranges from 42:57 in *Rh. choreutes* to 42:67 in *Rh. ignota*, that in wingless male always about 4:7. Proportional length between seventh and eighth dorsal abdominal segments in winged female is 56:52 in *Rh. ignota* and 60:44 in *Rh. formosa*, that in wingless female is 63:52 in *Rh. ignota* and 77:42 in *Rh. spinigera.*

Other group characters are as follows:

(1) The intermediate femur of female is transversely constricted at middle.

(2) The dorsum of abdomen of the wingless female is narrow after the first three segments. The connexivum is strongly reflexed for the last four segments.

(3) The pronotum in wingless forms completely covers mesonotum.

(4) The last three abdominal segments in the female have conspicuous bundles of black hairs except in *Rh. spinigera.*

(5) The second antennal segment is considerably longer than the third one.

(6) In the intermediate leg tibia is more than twice as long as the second tarsal segment; third tarsal segment is distinctly longer than the second one.

(7) In hind leg, the femur is longer than the tibia except in *Rh. choreutes.*

(8) Abundance of winged forms.

KEY TO THE SPECIES OF THE SPINIGERA GROUP ON THE BASIS OF THE WINGED FEMALE

1. Eighth segment on ventral surface strongly longitudinally elevated in the middle . . . . *Rh. ignota*

1. Eighth segment not elevated longitudinally in the middle of ventral surface 2

2. Apical margin of seventh connexival segment and lateral margin of eighth segment continuously sinuate . . . . *Rh. formosa*

2. Apical margin of seventh connexival segment not continuously sinuate with lateral margin of eighth segment 3
3. Lateral margin of eighth and the last genital segments with conspicuous bundles of long hairs . . . . *Rh. choreutes*
3. Lateral margin of eighth and the last genital segments without conspicuous bundle of long hairs . . . . *Rh. spinigera*

Rhagovelia choreutes Hussey

(Pl. 15, figs. 50a, b, c)

1925. *Rhagovelia choreutes* Hussey, Jour. New York Ent. Soc., vol. 33, pp. 61-69.

Winged male: Pronotum reaching middle of second dorsal abdominal segment, acutely pointed at apex. Forewings dark fuscous, veins black, greyish green above median basal vein, two long apical cells formed in the basal region of distal half of the wing. Proportional length of dorsal abdominal segments (third to seventh):: 25: 38: 38: 42: 57. Second segment with median longitudinal carinae slightly divergent and dilated posteriorly, with posteriorly a well-defined groove along posterior margin of first segment, anterolateral and posterolateral impressions clearly separated; intersegmental groove well defined and with longitudinal rugosities. Third segment with longitudinal carinae continuous with those on second segment, slightly divergent and dilated posteriorly, anteromesal, anterolateral and posterolateral impressions continuous; intersegmental groove well defined and sparsely longitudinally rugose. Seventh dorsal abdominal segment widened posteriorly. Metasternum behind transverse suture inclined posteriorly, shortened medially.

Wingless male: Proportional length of dorsal abdominal segments (first to seventh):: 35: 37: 37: 35: 35: 35: 60. First dorsal abdominal segment with anterior margin rounded and feebly produced anteriorly. Metasternum behind transverse suture inclined posteriorly, shortened in the middle.

Winged female: Seventh dorsal abdominal segment a little more than 1⅓ times as long as eighth segment in the middle; lateral margin of seventh connexival segment gently rounded, posterior margin feebly sinuate. Posterior margin of eighth segment broadly rounded. Conspicuous bundles of dark brown bristles arise at posterior angle of seventh connexival segment, lateral margin of eighth segment, and on lateral margin of the last genital segment.

Wingless female: Connexivum strongly reflexed and completely hides the apical half of dorsum beneath.

Rhagovelia formosa Bacon

(Pl. 15, figs. 48a, b, c)

1956. *Rhagovelia formosa* Bacon, Univ. Kansas Sci. Bull., vol. 38, pt. I, p. 867.

Winged female: Pronotum strongly produced apically, erected at about forty-five degrees, apex acute in dorsal view, upper margin rather densely clothed with dark hairs. Forewings dark fuscous, greenish in basal half, two apical cells formed in the same way as in the preceding species. Proportional length of dorsal abdominal segments (second to eighth):: 31: 38: 41: 45: 51: 60: 44. First dorsal abdominal segment with median elevated area well defined laterally and posteriorly. Second segment with longitudinal carinae rather thick and divergent posteriorly; anteromesal impression rather obsolete, anterolateral and posterolateral impressions subcontiguous; intersegmental groove sparsely longitudinally rugose. Third segment with longitudinal carinae slightly substraightly divergent posteriorly; anteromesal, anterolateral and posterolateral impressions clearly separated but placed on the depression continuous along posterior margin of second segment and along inner margin of third connexival segment; intersegmental groove well defined, sparsely longitudinally rugose. Connexivum subvertically reflexed in basal half. Seventh connexival segment with posterior angle subacutely produced, with a bundle of long, dark brown bristles. Eighth segment with lateral margin sinuate and continuous with sinuate posterior margin of seventh connexival segment. The last genital segment also provided with a bundle of long hairs directed lateroposteriorly. Posterior margin of seventh ventral abdominal segment with brown apically curved hairs throughout. Eighth ventral abdominal segment strongly elevated longitudinally in the middle. Metasternum behind transverse suture subequal in length throughout.

Wingless female: Posterior margin of pronotum feebly sinuate. Posterior margin of metanotum finely denticulated. Connexivum completely covers the dorsum beneath after third segment. Proportional length of dorsal abdominal segments (first to third):: 40: 40: 33 (allotype). Anterior margin of first abdominal segment roundly produced anteriorly. Eighth ventral abdominal segment strongly elevated in the middle. Metasternum behind transverse suture rather short as in winged female.

Wingless male: Pronotum covers mesonotum completely. Proportional length of dorsal abdominal segments (first to seventh):: 37:

35: 33: 30: 31: 36: 63 (holotype). First dorsal abdominal segment roundly produced anteriorly.

Rhagovelia ignota Drake and Harris

(Pl. 15, figs. 49a, b, c)

1933. *Rhagovelia ignota* Drake and Harris, Proc. Biol. Soc. Washington, vol. 46, p. 51.

Winged male: Pronotum acutely pointed at apex, strongly cylindrically produced posteriorly and erected at about sixty degrees, extreme apex acutely pointed. Forewings dark fuscous, veins darker, with yellowish green tinge in basal half, with two large apical cells. Proportional length of dorsal abdominal segments (first to seventh):: 20: 32: 36: 38: 36: 42: 67. First dorsal abdominal segment with median elevated area well defined posteriorly and laterally. Second segment with longitudinal carinae dilated and divergent posteriorly; anteromesal impression rather obliterated, anterolateral and posterolateral impressions clearly separated; intersegmental groove between second and third segments well defined, with four ill-defined impressions in the specimen examined. Third segment with longitudinal carinae divergent posteriorly; anteromesal impression obliterated; intersegmental groove between third and fourth segments finely and longitudinally rugose. Fourth segment with a faint longitudinal carinae which becomes obsolescent before they reach to the middle of the segment. Metasternum behind transverse suture slightly shortened medially. Eighth segment on dorsal side strongly widened posteriorly. Seventh ventral abdominal segment strongly inclined posteriorly, with large round elevation on either side of the middle, its posterior margin broadly roundly emarginated. Eighth segment on ventral side with a round strong protuberance covered with hairs.

Wingless male: Proportional length of dorsal abdominal segments (first to seventh):: 33: 35: 33: 30: 30: 38: 70. Body beneath as in winged male.

Winged female: Proportional length of dorsal abdominal segments (fourth to eighth):: 43: 43: 50: 56: 52. Posterior margin of seventh dorsal abdominal segment broadly sinuate; seventh connexival segment strongly roundly widened and reflexed, posterior half of lateral margin with long dark-brown hairs; posterior margin of seventh ventral abdominal segment with a bundle of long black bristles on either side of the middle. Eighth segment with lateral margin broadly rounded, connected with apical margin of seventh connexival segment at middle, with a thick bundle of long black hairs directed posteriorly, posterior margin broadly rounded. Metasternum behind transverse suture level, slightly shortened medially.

Wingless female: Proportional length of dorsal abdominal segments (first to eighth):: 51: 41: 45: 31: 37: 48: 63: 52. Connexivum vertically reflexed after third segment. Dorsum narrowed after third segment.

Rhagovelia spinigera Champion

(Pl. 15, figs. 51a, b, c)

1898. *Rhagovelia spinigera* Champion, Biol. Centr. Amer., Het., vol. 2, p. 137.

Winged male: Pronotum acutely pointed apically. Forewings dark fuscous, with yellowish green tinge in basal half. Proportional length of dorsal abdominal segments (first to seventh):: 24: 38: 35: 37: 36: 43: 70. First dorsal abdominal segment with median elevated area well defined posteriorly and laterally. Second segment with longitudinal carinae divergent at base, thickened near posterior margin of second segment; anteromesal impression obliterated, depressed and laevigate along posterior margin of first segment on either side of the base of carinae, anterolateral and posterolateral impressions clearly separated; intersegmental groove obscurely defined. Third segment with longitudinal carinae subparallel-sided, thickened apically; anteromesal, anterolateral and posterolateral impressions continuous; intersegmental groove between third and fourth segments obscurely longitudinally rugose. Fourth segment with faint longitudinal carinae which become evanescent at middle of the segment. Seventh dorsal abdominal segment strongly widened apically. Posterior margin of seventh ventral abdominal segment deeply and broadly emarginated. Metasternum behind transverse suture shortened medially.

Wingless male: Proportional length of dorsal abdominal segments (first to seventh):: 35: 35: 35: 32: 31: 40: 72. Metasternum behind transverse suture inclined posteriorly, shortened in the middle.

Winged female: Pronotum developed into a long process apically, erected at about forty-five degrees, apex subacutely pointed. Connexivum strongly reflexed. Seventh dorsal abdominal segment with posterior margin feebly sinuate; seventh connexival segment with posterolateral margin broadly rounded, without conspicuous bundle of hairs; posterior margin of seventh ventral abdominal segment straight in the middle. Eighth segment with lateral margin rounded, without conspicuous bundle of hairs.

Wingless female: Proportional length of dorsal abdominal segments (first to eighth):: 47: 43: 38: 33: 35: 45: 77: 42. Connexivum strongly reflexed but not completely covering dorsum beneath, or sometimes completely covers the dorsum beneath.

DISCUSSION OF CHARACTERS

Longitudinal carinae: In the *angustipes* and *abrupta* groups longitudinal carinae always occur distinctly on the second segment extending from the anterior margin to posterior margin of the segment. More or less indistinct carinae also often occur on the third segment which tend to be subjected to individual variation within a species. Rarely the carinae reach almost to the posterior margin of the third segment (*Rh. spinosa*), but never extend into the intersegmental groove.

As far as the longitudinal carinae are concerned there is no significant difference between the *angustipes* group and the *abrupta* group.

In the other species groups of this genus, except for the *hirtipes* group, distinct carinae occur on the second and third segments. Occasionally the carinae extend down to a part of the fourth abdominal segment as is seen typically in *Rh. ainslei* of the *ainslei* group.

There is, thus, a clear-cut distinction in this character between the two major groups, the one represented by the *angustipes* and *abrupta* groups and the one represented by the *elegans, crassipes, ainslei, collaris, obesa,* and *spinigera* groups respectively.

A possible exception is the carinae in *Rh. collaris* of the *collaris* group, in which the carinae at least do not extend into the intersegmental groove between the third and fourth segments, a condition which was observed in one individual of *Rh. spinosa* of the *angustipes* group.

The third type of carinae occurs in *Rh. hirtipes.* In this species the carinae reach barely to the middle of the second segment.

The carinae occasionally give a species-group character, for instance, in typical species of the *elegans* group (*Rh. uncinata, Rh. elegans, Rh. insularis*) the carinae are always fine, well defined and roundly produced laterally in the middle; in typical species of the *collaris* group (*Rh. impensa, Rh. scabra, Rh. armata, Rh. acuminata*) the lateral margins of the longitudinal carinae are more or less ill defined. The related species tend to have similar carinae, and many other similar characters.

Structures associated with longitudinal carinae: This development of the intersegmental groove, and the anteromesal, anterolateral and posterolateral impressions, are closely correlated with the development of longitudinal carinae. These structures tend to be poorly developed on the third dorsal abdominal segment of the *angustipes* and *abrupta* groups in which the carinae are absent or poorly developed. In other major groups, represented by the *elegans, crassipes, obsea, spinigera, collaris,* and *ainslei* groups, in which the carinae are well developed on the third segment, these associated structures are also well developed. In *Rh. hirtipes* of the *hirtipes* group the structures are much less conspicuous than in most species of the *angustipes* group and are lacking on the third segment.

First dorsal abdominal segment: The first dorsal abdominal segment does not give good group characters. The development of the median elevated area seems to be associated with the development of the longitudinal carinae on the second segment. In *Rh. hirtipes* the median elevated area is more or less obliterated laterally. In the *elegans* group the posterior margin of the median elevated area is roundly concave.

Pronotum in winged forms: In the *angustipes* and *abrupta* groups the pronotum is more or less broadly rounded apically, and reaches usually to the first dorsal abdominal segment; there is no sexual difference in shape. In other species groups the pronotum of wingless females offers a good group character, *i. e.*, in the *elegans* and *crassipes* groups there occurs no apical prolongation into a process except in the female of *Rh. crassipes.* In the other species groups (*ainslei, obesa, collaris, spinigera* groups) the pronotum develops into a more or less conspicuous processlike prolongation in the female, and each species group has a more or less peculiar type of modification in the apical part of the pronotum, *i. e.*, in the *ainslei* group, it is represented by a long simple process, in the *obesa* group it is short and thick, in the *collaris* group it is a long process with a more or less conspicuous projection at the base of the apical process, and in the *spinigera* group it is a rather simple prolongation.

Pronotum in wingless forms: The length of the pronotum in wingless forms is one of the most important characters upon which Bacon based his classification. There exists a clear-cut difference in length between the *angustipes* group and the *abrupta* groups, but there is a clearer distinction in length of the pronotum between the *abrupta* group and the rest of species groups in which the pronotum always covers the mesonotum (exception: *Rh. insularis*). As already described there occurs a short processlike prolongation in the wingless female of *Rh. oriander.*

Forewing venation: Three types of venation occur in the forewing of *angustipes* group as seen from the accompanying text figures. All species of this group observed have one or another of these three types of wing venation.

In the *angustipes* group the subcosta reaches the middle of upper margin of the wing. The number of apical cells ranges from one to two and are formed always in the proximal half of the wing. In the *abrupta* group two apical cells are always distinct in all three species examined, and they are also formed in the proximal half of the wing; the subcosta reaches the middle of upper margin of the wing. A clear distinction in forewing venation does not exist between the two groups. Actually the wing venations of *Rh. angustipes* and that of *Rh. abrupta* are essentially the same (as will be noted from the accompanying text figures). In some species of the *angustipes* group the wing venation is on further reduction in its evolutionary path.

The forewing venation in other species groups within the genus is strikingly the same throughout, apart from almost indescribable minor specific differences. The subcosta always reaches to the apical one fourth of the upper margin of the wing; apical cells are always formed within the distal half of the wing, of which the upper one is always narrower and located more distally than the lower one.

Proportional length of the femur to the tibia in the hind leg: In twenty out of twenty-two species of the *angustipes* group the femur is shorter than the tibia. In the *abrupta* group this relation is reversed, and the femur is distinctly longer than the tibia except for *Rh. lucida* in which it is just slightly longer. In *Rh. hirtipes* the femur is shorter than the tibia. In the *elegans* group they are equal or subequal in length. In all other groups the femur is always distinctly longer than the tibia except for *Rh. choreutes* in the *spinigera* group, *Rh. rivale* in the *obesa* group, *Rh. collaris* and *Rh. tayloriella* in the *collaris* group, and *Rh. ainslei* in the *ainslei* group.

The proportional length of the femur to the tibia in the hind leg of the *angustipes* group is decidedly different from all other species groups except the *hirtipes* group.

Proportional length of the tibia to the second tarsal segment in the intermediate leg: In sixteen out of twenty-two species of the *angustipes* group the tibia is less than twice as long as the second tarsal segment. In all other groups the tibia is more than twice as long as the second tarsal segment except in *Rh. hirtipes, Rh. obesa,* and *Rh. rivale* of the *obesa* group and three species of *ainslei* group. In this character the *angustipes* group is again peculiar.

Proportional length of the second tarsal segment to the third segment in the intermediate leg: In the *angustipes* group the second segment is distinctly longer than the third one in six species and in the males of three species. In all other groups the second segment is shorter than the third one except for *Rh. hirtipes* and the *ainslei* group represented by three species.

Proportional length of antennal segments: The first segment is always the longest throughout the genus. In the *angustipes* group the third segment is slightly longer than the second one in the majority of species. In all other groups the second and third segments are subequal in length to each other except for the *ainslei* group, in which the second segment is much longer than the third one. The proportional length of the antennal segments is not a good group character.

Proportional length of dorsal abdominal segments: The proportional length of the sixth and seventh segments in the male, and of the seventh and eighth segments in the female were analysed and no very significant group character was found throughout the genus. However, it should be noted that in wingless males of the *angustipes* group the seventh segment is almost always a little less than twice as long as the sixth segment. In all other groups the seventh segment is much less than twice as long as the sixth segment in the majority of species.

As to the proportional length of the seventh and eighth segments in wingless females, there is no significant difference among the different groups. The seventh segment is a little longer than the eighth segment except for several abnormal cases. Noteworthy also is the proportion in *Rh. hirtipes* in which the seventh segment is twice as long as the eighth segment.

Connexivum in wingless forms: The connexivum in wingless females is more or less strongly reflexed and often folded on the dorsum in all groups except for the *crassipes* group in which the connexivum is never reflexed at an angle more than ninety degrees. This character is more a specific than a group character.

Dorsal seventh and eighth abdominal segments in winged female: The structure in the dorsal seventh and eighth abdominal segments in winged females offers a good species-group character. Each species group shows more or less constant characters in the shape of the seventh connexival segment, arrangement of setae, shape of the paratergite in the eighth segment, etc. In the *angustipes* and *abrupta* groups the seventh connexival segment is elongate subtriangular in shape, straightly narrowed apically, apex never produced laterally, always continuous with the lateral margin of the eighth segment. The distinction between the two groups, however, lies in the shape of seventh dorsal abdominal segment. In the *abrupta* group the segment is always longer than wide; in the *angustipes* group it is wider than long or as long as wide except for *Rh. janeira* in which it is a little longer than wide. In the *elegans* and *crassipes* groups the structure in the seventh and eighth segments is similar; in both groups the apex of the seventh connexival segment is never produced and always continuous with the lateral margin of the eighth segment. The *elegans* group is decidedly different from the *crassipes* group in that the inner margin of the seventh connexival segment is always sinuate. In four other groups, *i. e., collaris, obesa, ainslei,* and *spinigera* groups the apical portion of the seventh connexival is subrectangular or broadly rounded. In the *ainslei* group (except for *ainslei*) the seventh connexival segment is strongly narrowed and produced posteriorly. The distinction between the *collaris* (except for *Rh. collaris* and *Rh. tayloriella*) and the *obesa* group is that the lateral margin of the seventh connexival segment is gently rounded while in the *obesa* group (except for *Rh. distincta*) the lateral margin of the seventh connexival segment is sinuate in the apical half. The structure in *Rh. hirtipes* is characterized by its narrow, lustrous seventh connexival segment and two very conspicuous pairs of bundles of setae on the lateral margin of the eighth segment. The basic plan of the structure in *Rh. hirtipes* seems to be closer to that of the *abrupta* group, than to any other groups.

Other characters: The area behind the transverse suture in the metasternum was examined. It was found that the area is almost always level in the *angustipes* group and inclined posteriorly in the *abrupta* group. In all other groups the structure behind the transverse suture in the metasternum seems to be specific rather than a group character. It should be noted that occasionally the area is not inclined in female while it is level in the male in some species.

The location of spiracles on each abdominal segment was found to give no group character. The metathoracic scent-gland opening is obsolescent, but occasionally it is rather clearly visible, but this character apparently is not a group character. The occasional occurrence of a more or less distinct longitudinal ridge on the ventral surface of the abdomen, and black minute spines on the posterior margin of the seventh ventral abdominal segment in the male, were found to be specific characters.

CLASSIFICATION

It has now become increasingly evident from the discussion of various characters that, first of all, the *angustipes* group and the *abrupta* group have two characters in common in winged forms, *i. e.*, both groups have exactly identical patterns in the shape of longitudinal carinae on the second and third dorsal abdominal segments, and the forewing venation. Also in these two groups the pronotum in wingless forms is decidedly shorter than that in other groups in which the length of the pronotum is very constant in wingless forms.

In all other groups, except for *Rh. hirtipes*, all kinds of group characters overlap each other as seen from the above discussion on characters. The only common denominators throughout the groups are longitudinal carinae on the second and third segments and occasionally on the fourth segment, very constant forewing venation in winged forms, and also the very constant long pronotum in wingless forms. All these characters are decidedly different from their counterparts shared by both the *angustipes* group and the *abrupta* group. There is, thus, a clear-cut line that separates one major group (subgenus), comprising the *angustipes* and the *abrupta* groups, on one hand, and the other major group (subgenus), comprising *elegans, crassipes, collaris, spinigera, ainslei* and *obesa* groups on the other.

The peculiarities of *Rh. hirtipes* Drake and Harris were already pointed out in the description of this species. In the characters upon which we are here separating the major groups of the genus, this species has one characteristic in common with the latter group, *i. e.*, the character of the pronotum in wingless forms. The longitudinal carinae are quite different from either one of the two types, although they are closer to the characteristics of the former group. Unfortunately, the forewing venation is not available for study because of the incomplete condition of the specimens at hand. This species, however, represents a group quite distinct from the two above groups in some other peculiar characters, such as the structure of male clasper, the last genital segment in the female, and quite distinct proportional length between the seventh and eighth dorsal abdominal segments in the wingless female, etc.

The above discussion seems to justify the proposal of three subgenera representing the major groups of the genus *Rhagovelia.* However, the forewing of *Rh. hirtipes* is not available for description, so the description of the new subgenus to receive this species is postponed until a complete specimen of the winged form and more species representing this group become available.

The type of the genus *Rhagovelia* is *Rhagovelia nigricans* (Burmeister). The writer has examined a specimen of this species from Ceylon preserved in the Francis Huntington Snow Museum, University of Kansas and found that this species has a long pronotum in the wingless forms and the forewing has large apical cells formed in the distal half of the wing. This clearly shows that this species represents one of the major groups which comprise the *elegans, crassipes, collaris, ainslei, spinigera,* and *obesa* groups.

DESCRIPTION OF SUBGENERA

Rhagovelia (Rhagovelia) s. str.

Type of subgenus: *Rhagovelia* (*Rhagovelia*) *nigricans* (Burmeister)

Pronotum in wingless forms long, usually completely covering mesonotum. Pronotum in winged forms often developing into a long projection apically in female. Forewing with two large apical cells formed in distal half of the wing; subcosta reaches as far as apical one fourth of the wing. Distinct longitudinal carinae always occur on the second and third dorsal abdominal segments, the carinae occasionally extending back to a part of fourth abdominal segment. Usually hind tibia is shorter than hind femur.

Rhagovelia (*Neorhagovelia*) new subgenus

Type of subgenus: *Rhagovelia* (*Neorhagovelia*) *angustipes* Uhler

Pronotum in wingless forms short, never covering mesonotum completely; pronotum in winged forms broadly rounded, never developing into a conspicuous projection apically. Forewing with apical cells more or less obliterated; one or two apical cells always formed in proximal half of the wing; subcosta not extending beyond the middle of wing. Distinct longitudinal carinae always occur on second dorsal abdominal segment, more or less obliterated and not reaching to intersegmental groove when they occur on third segment. Usually hind tibia is longer than hind femur. Seventh connexival segment in winged female not produced laterally at apex.

PHYLOGENY

The study of the winged forms has revealed a few additional characters which should be considered from the viewpoint of phylogeny.

First of all, the forewing in the subgenus *Rhagovelia* is distinctly more generalized than in the subgenus *Neorhagovelia*. In this character the subgenus *Rhagovelia* is more primitive than the subgenus *Neorhagovelia*.

We do not know the adaptational significance of the longitudinal carinae on the basal dorsal abdominal segments in winged forms, but the occurrence of the carinae on fewer segments can safely be regarded as the more generalized condition. In this sense the subgenus *Neorhagovelia* is more primitive than the subgenus *Rhagovelia*.

The varying degree of specialization in the apical part of the pronotum in winged females can be arranged from the less to the more specialized in the following order:

Subgenus	*Neorhagovelia*	Without modification.
Subgenus	*Rhagovelia*	
	elegans group	Without modification
	crassipes group	Modification rarely occurs.
	obesa group	Modified into a short and thick process.
	spinigera group	Modified into a rather short and simple process.
	ainslei group	Modified into a long and simple process.
	collaris group	Modified into a long process with further modification at base of the apical process.

It is interesting to point out that this arrangement agrees with Bacon's phylogenetic scheme based on the length of pronotum in wingless forms, general shape of the dorsum, and genital segments in wingless forms, except for position of the *collaris* group, a group in which the pronotum is the most highly specialized in winged females.

The area behind the transverse suture in the mesosternum is almost always level in the *angustipes* group of the subgenus *Neorhagovelia*, while in the subgenus *Rhagovelia* the area is usually strongly inclined posteriorly. The latter condition can be regarded as secondary.

Rh. hirtipes Drake and Harris seems to have more characters in common with the subgenus *Neorhagovelia*, although the pronotum in the wingless forms is just like that of the subgenus *Rhagovelia*, proportional length of the hind femur to the tibia in the hind leg, the proportional length between the second and third tarsal segments in the intermediate leg, the pronotum in winged forms seem to indicate its common origin with the *angustipes* group. Further clarification of its phylogenetic relationship with other groups must await the study of wing venation and additional species representing this group.

CONCLUSION

The result of this study has revealed some basic concepts applicable to the taxonomy of the Hemiptera-Heteroptera in particular and to taxonomic entomology in general.

Firstly, the importance of the study of winged forms in the classification of this genus has been clearly shown in the present study. Some hitherto-neglected taxonomic characters have been found to be of importance in defining the groups of species and in considering the phylogenetic relationship within the genus. The importance of the more serious study of winged forms in some other families of aquatic Hemiptera is anticipated.

Secondly, the first category of the writer's hypothesis has been found to hold up in this genus. Each particular type of longitudinal carinae in the basal dorsal abdominal segments was found to be well correlated, at least, with each distinct type of the pronotum and the wing venation. The further test of the hypothesis in other groups of Hemiptera-Heteroptera is strongly desired.

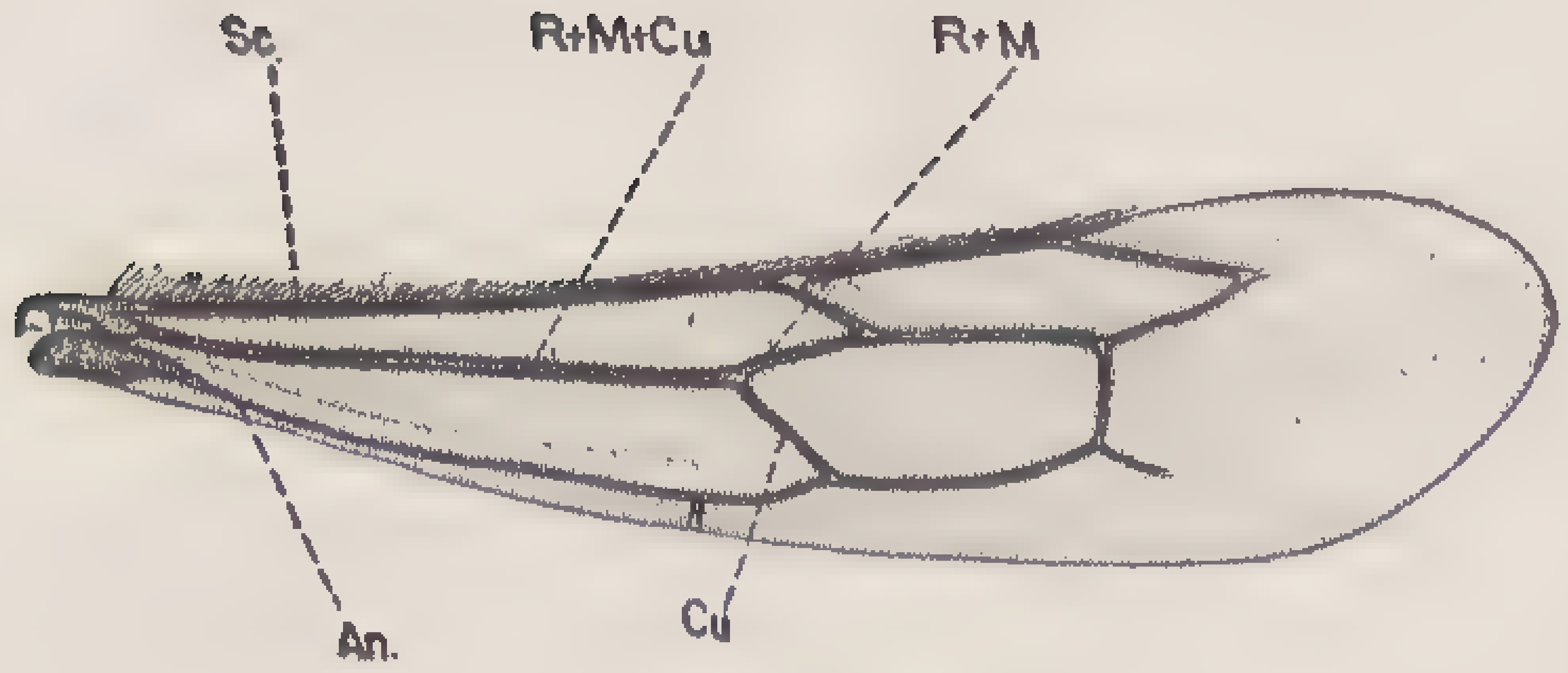
Thirdly, the applicability of the deductive method (postulation of hypothesis, followed by a test of the hypothesis by further investigation of facts) in taxonomic entomology was shown in this study. The deductive method, when it works, is much more effective than the purely inductive method in detecting principles that underlie facts, as has always been true in many fields of scientific research.

Lastly, the indication, as a result of application of the method here adopted, is that the heteropteran genera tend to split. This is what was experienced in this study and in the study "Generic classification of the Aradidae" by Usinger and Matsuda. However, the writer feels certain that we will eventually have a clearer understanding of phylogenetic relationship and a clearer picture of worldwide distribution of groups of Hemiptera-Heteroptera in terms of more clearly defined generic and subgeneric concepts which can be obtained by a careful application of this method.

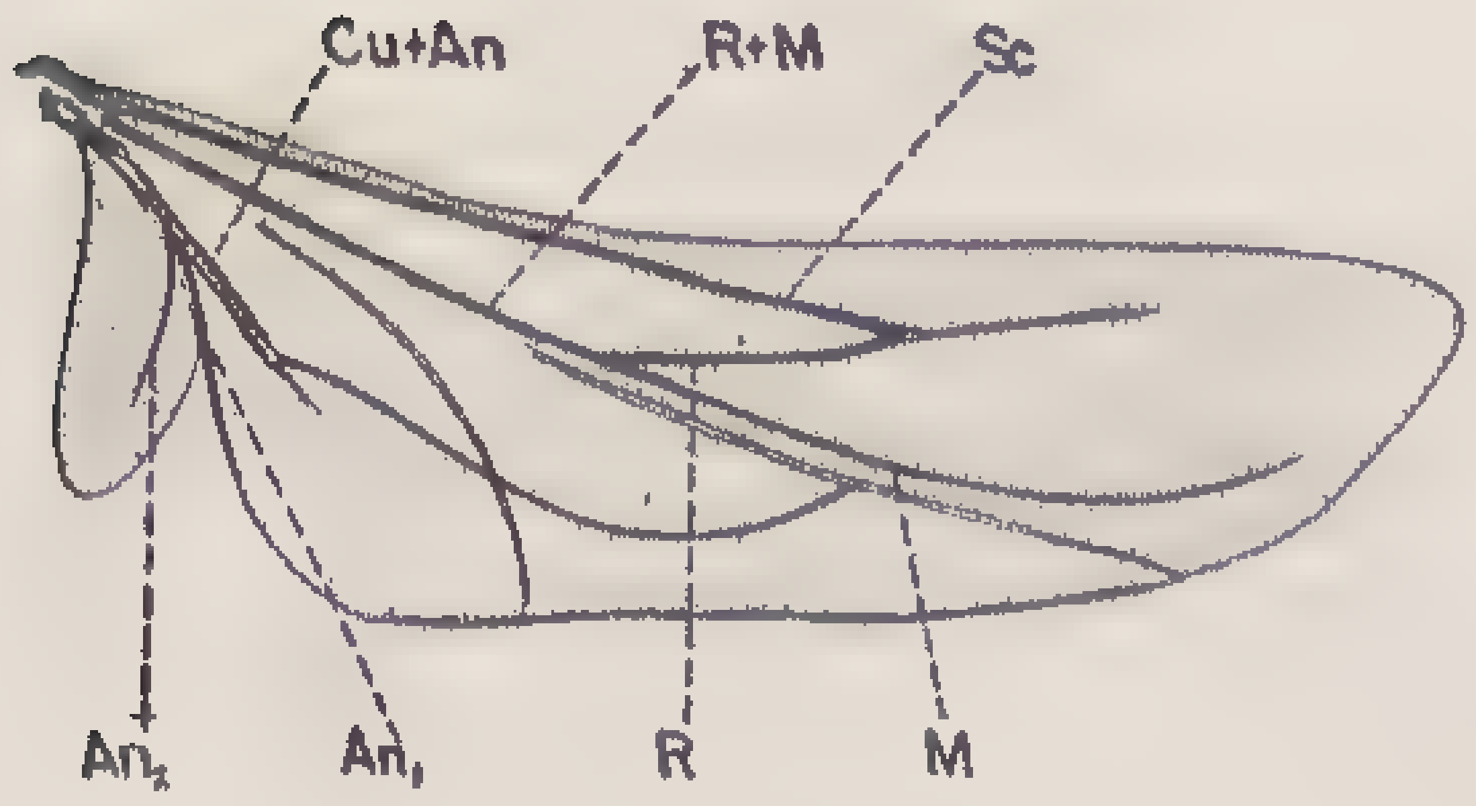
PLATE 3

1. Forewing of *Rhagovelia* (*Rhagovelia*) *insularis* Champion.
2. Hind wing of *Rhagovelia* (*Rhagovelia*) *insularis* Champion.
3. Forewing of *Rhagovelia* (*Neorhagovelia*) *versuta* Drake and Harris.
4. Hind wing of *Rhagovelia* (*Neorhagovelia*) *versuta* Drake and Harris.
5. Forewing of *Rhagovelia* (*Neorhagovelia*) *bisignata* Bacon.
6. Forewing of *Rhagovelia* (*Neorhagovelia*) *angustipes* Uhler.
7. Forewing of *Rhagovelia* (*Neorhagovelia*) *abrupta* Gould.

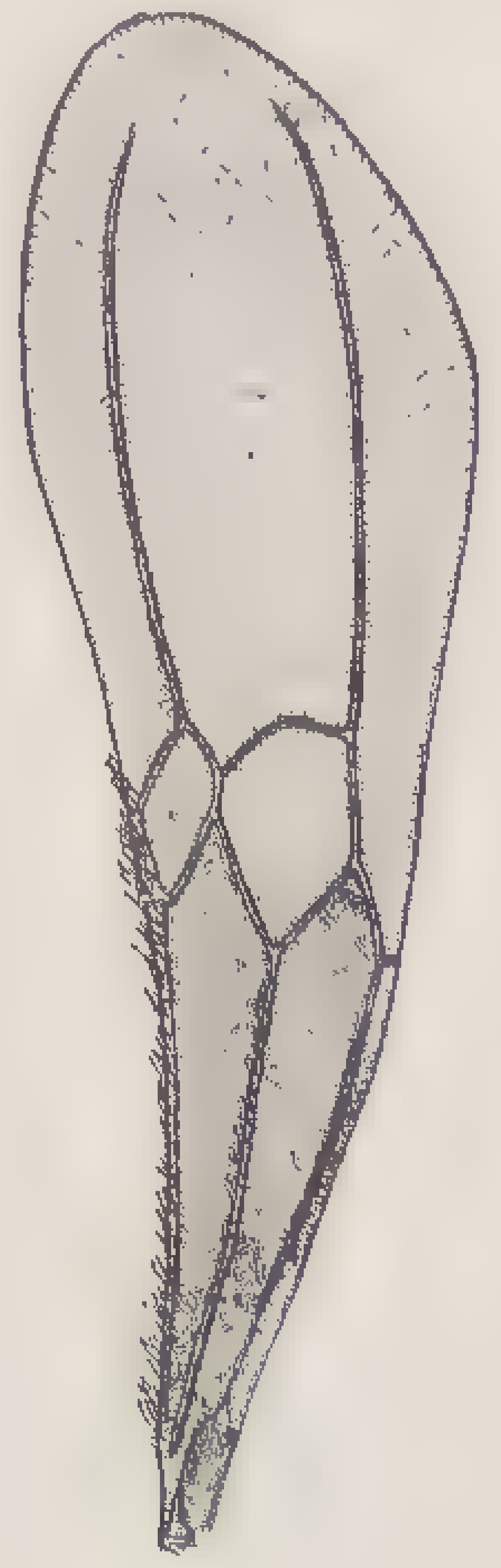
PLATE 3



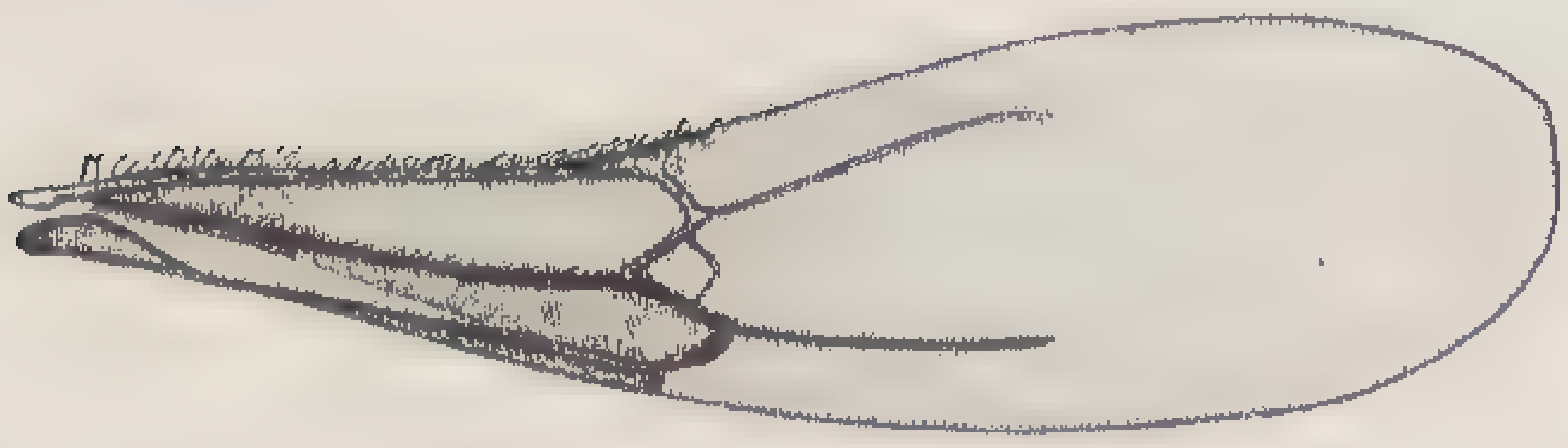
1. R. (R.) insularis



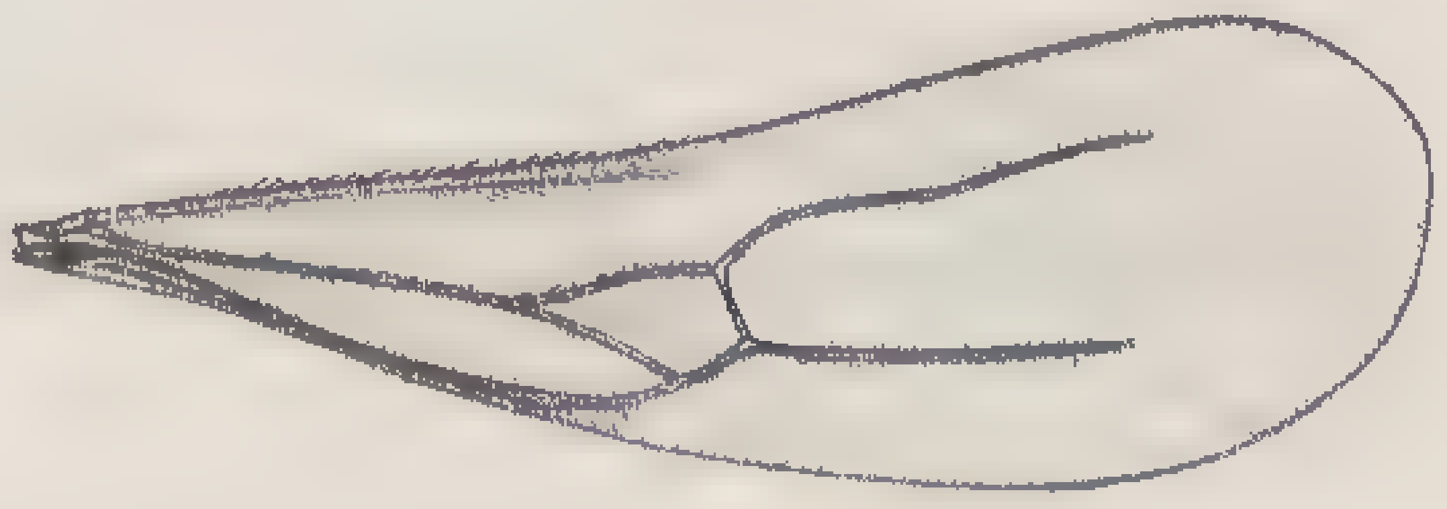
2. R. (R.) insularis



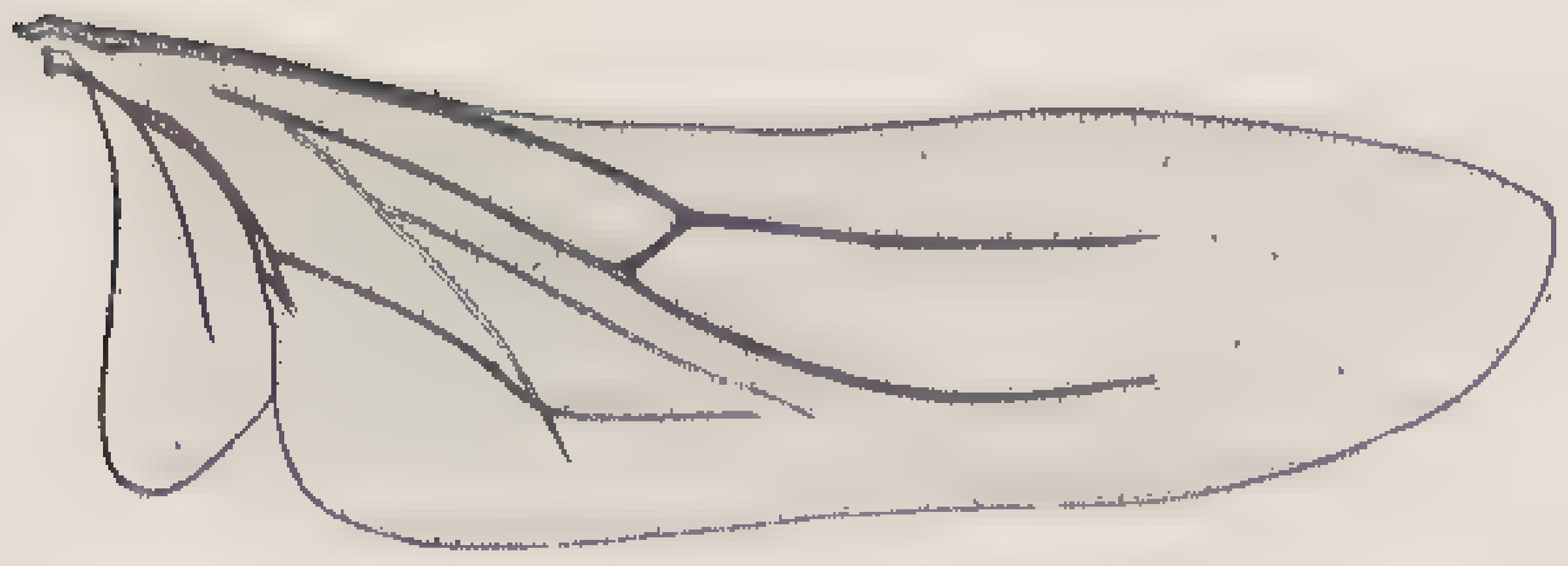
7. R. (N.) abrupta



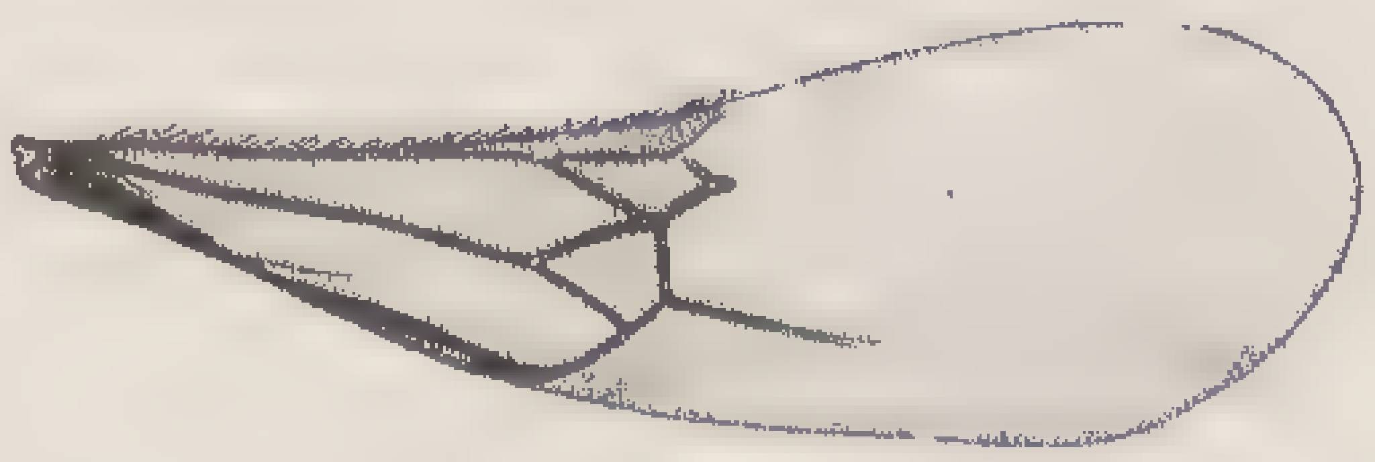
3. R. (N.) versuta



5. R. (N.) bisignata



4. R. (N.) versuta



6. R. (N.) angustipes

PLATE 4

DORSAL VIEW OF ABDOMINAL SEGMENTS

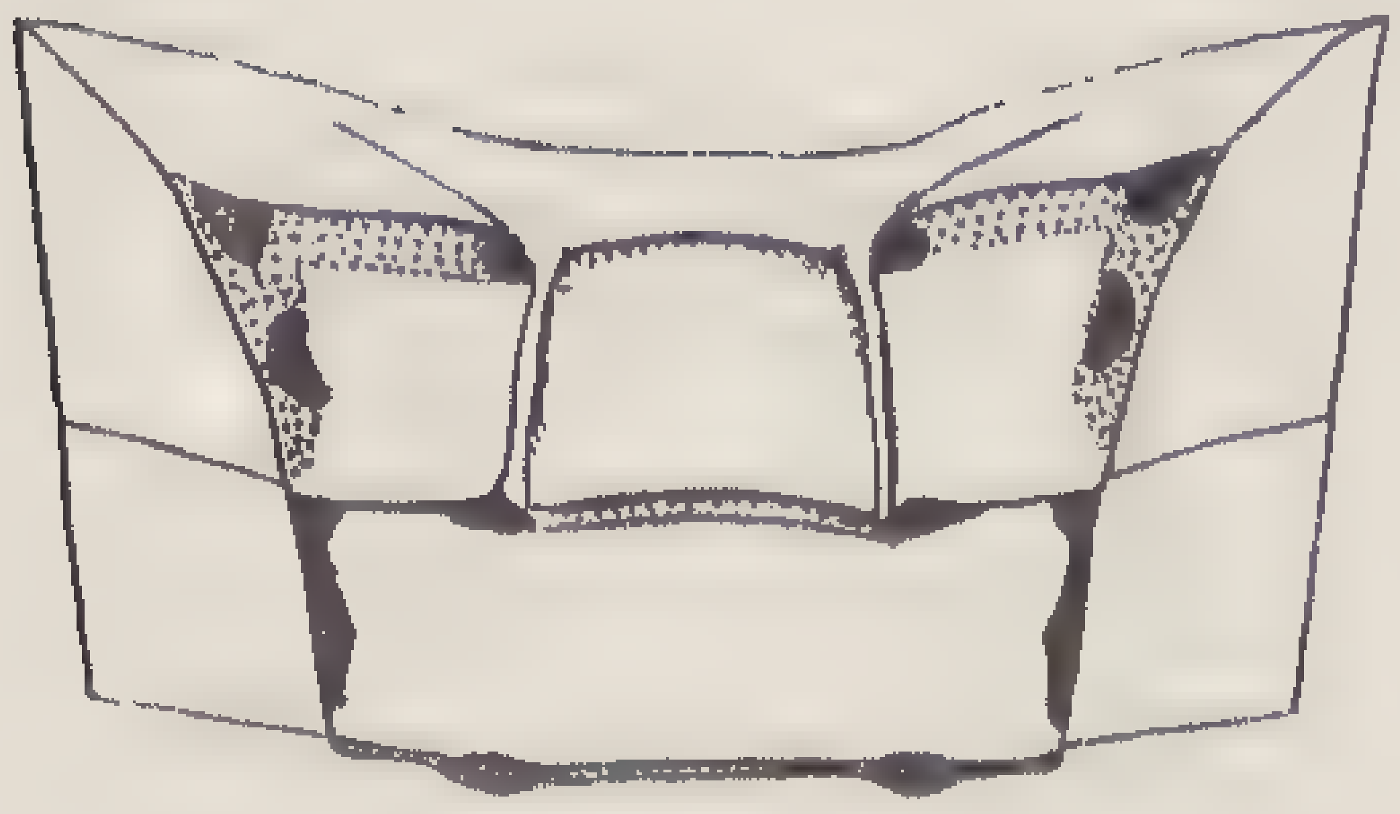
FIG. 8a. Basal segments of *Rhagovelia* (*Neorhagovelia*) *angustipes* Uhler; 8b, apical segments of winged female.

FIG. 9a. Basal segments of *Rhagovelia* (*Neorhagovelia*) *bisignata* Bacon; 9b, apical segments of winged female.

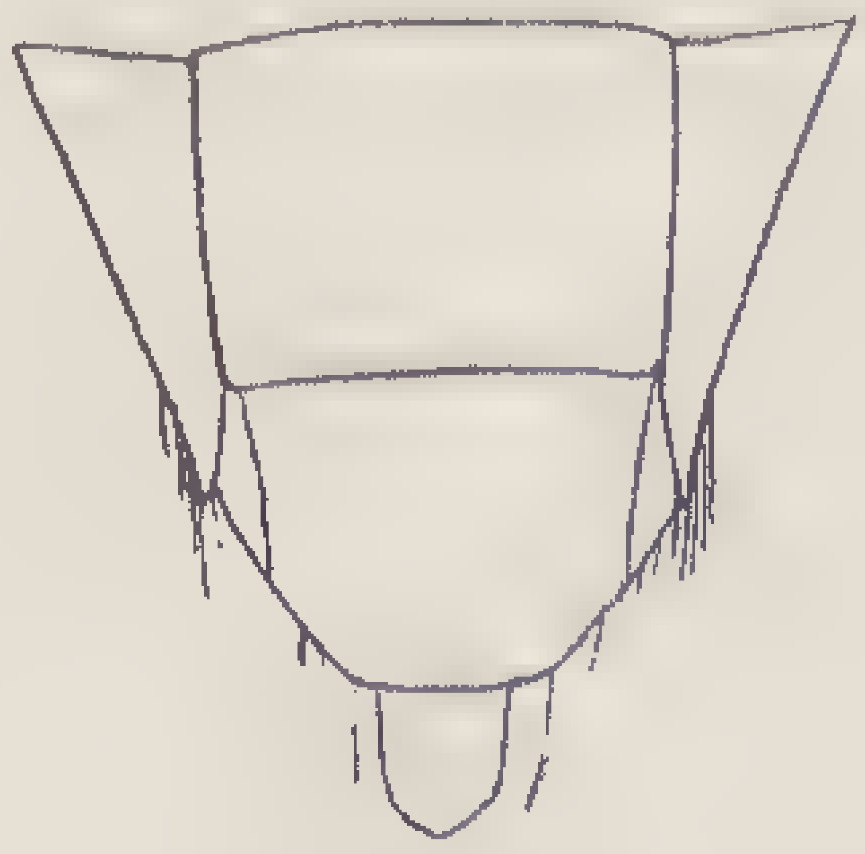
FIG. 10a. Basal segments of *Rhagovelia* (*Neorhagovelia*) *calopa* Drake and Harris; 10b, apical segments of winged female.

FIG. 11a. Basal segments of *Rhagovelia* (*Neorhagovelia*) *fontanalis* Bacon; 11b, apical segments of winged female.

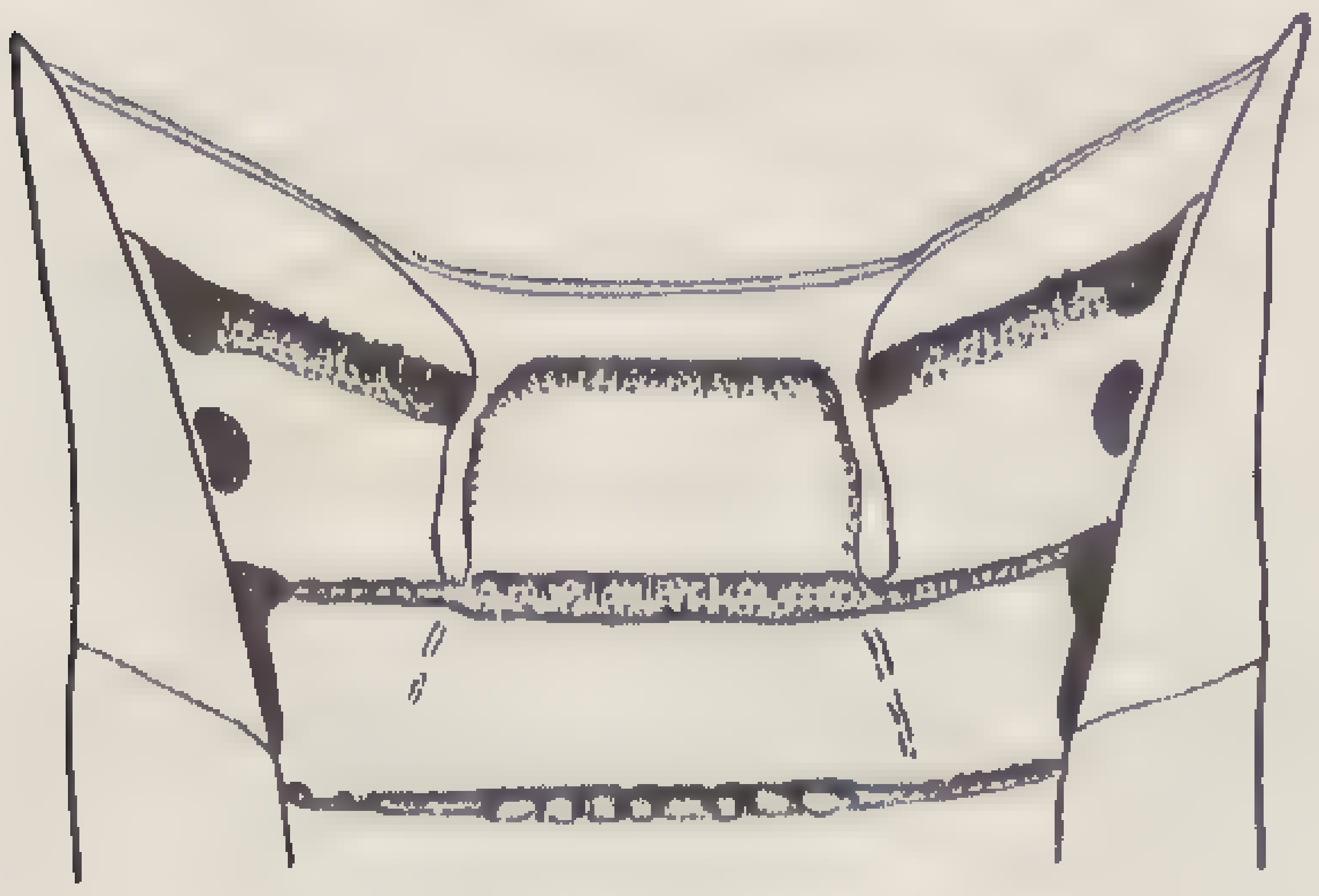
PLATE 4



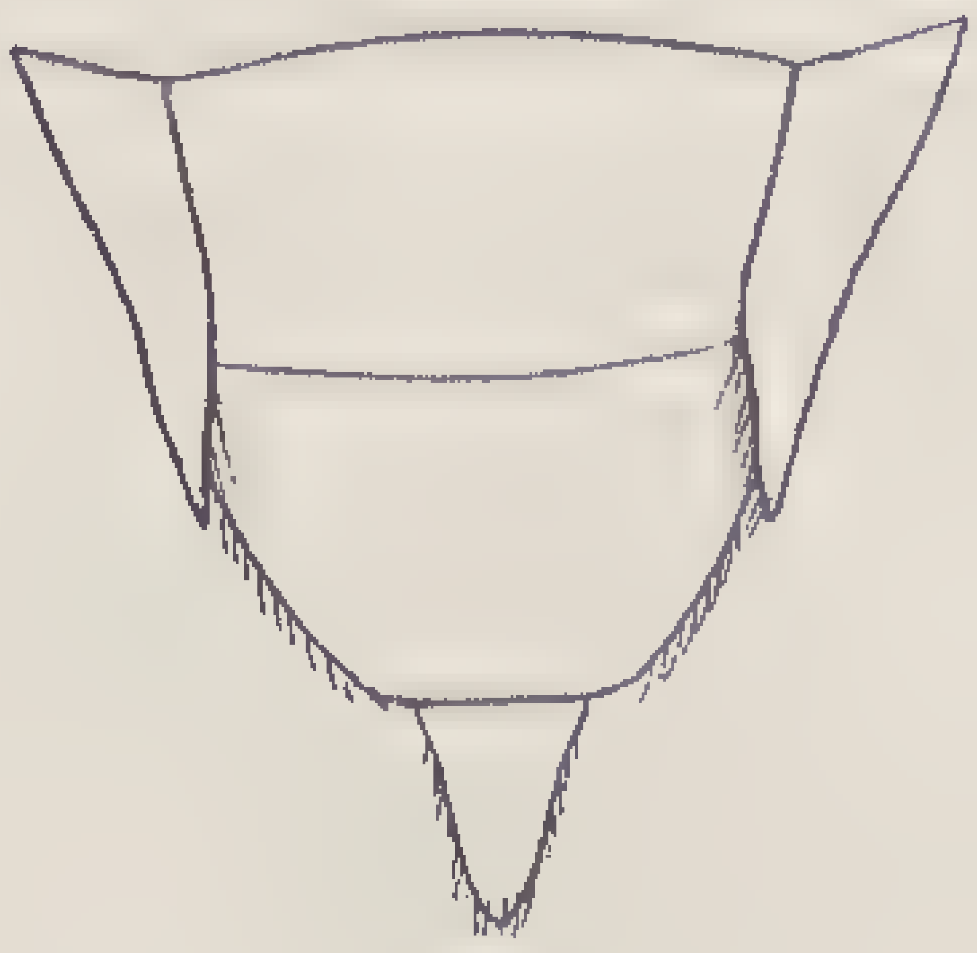
8a R. (N.) angustipes



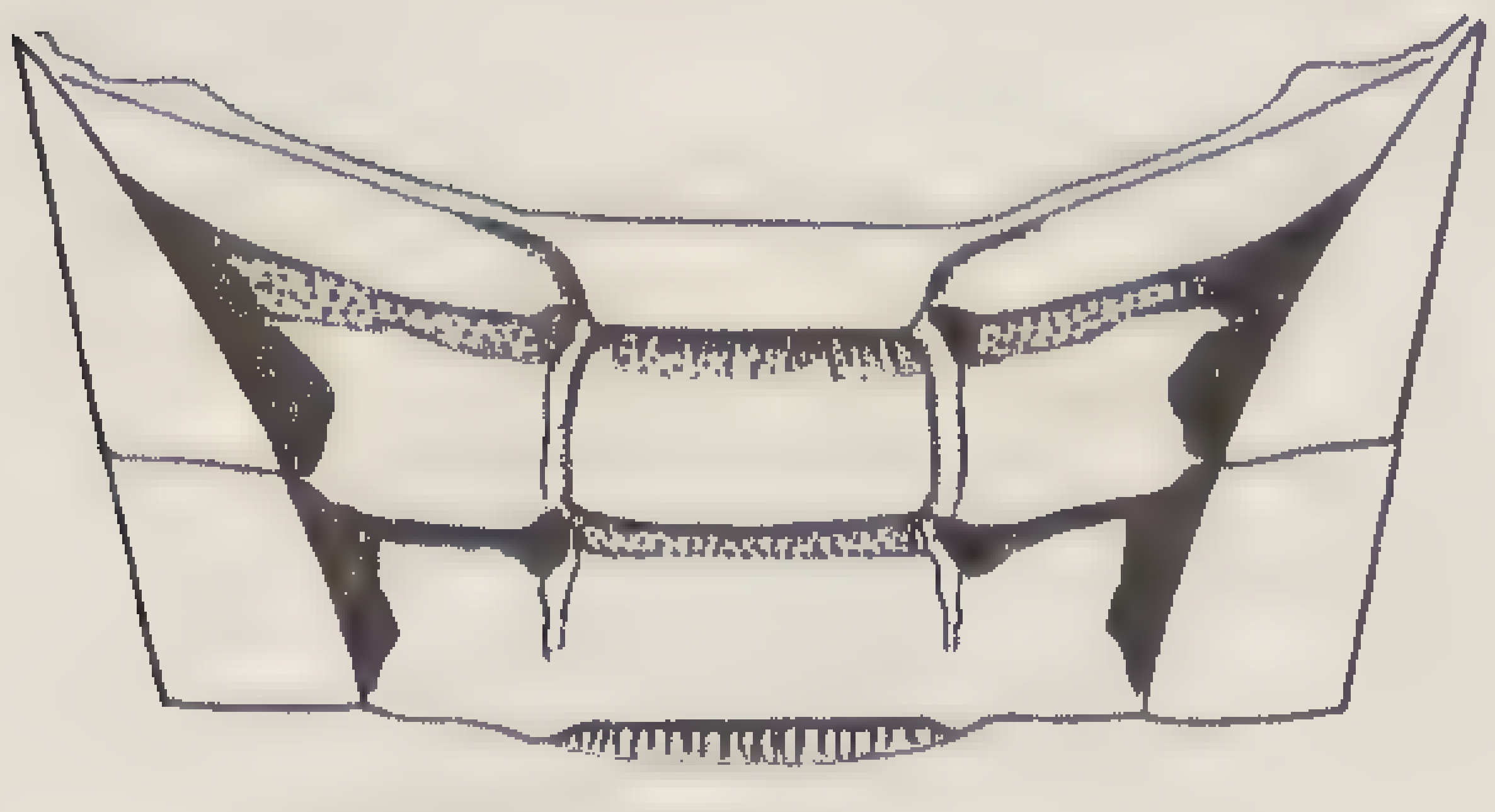
8b



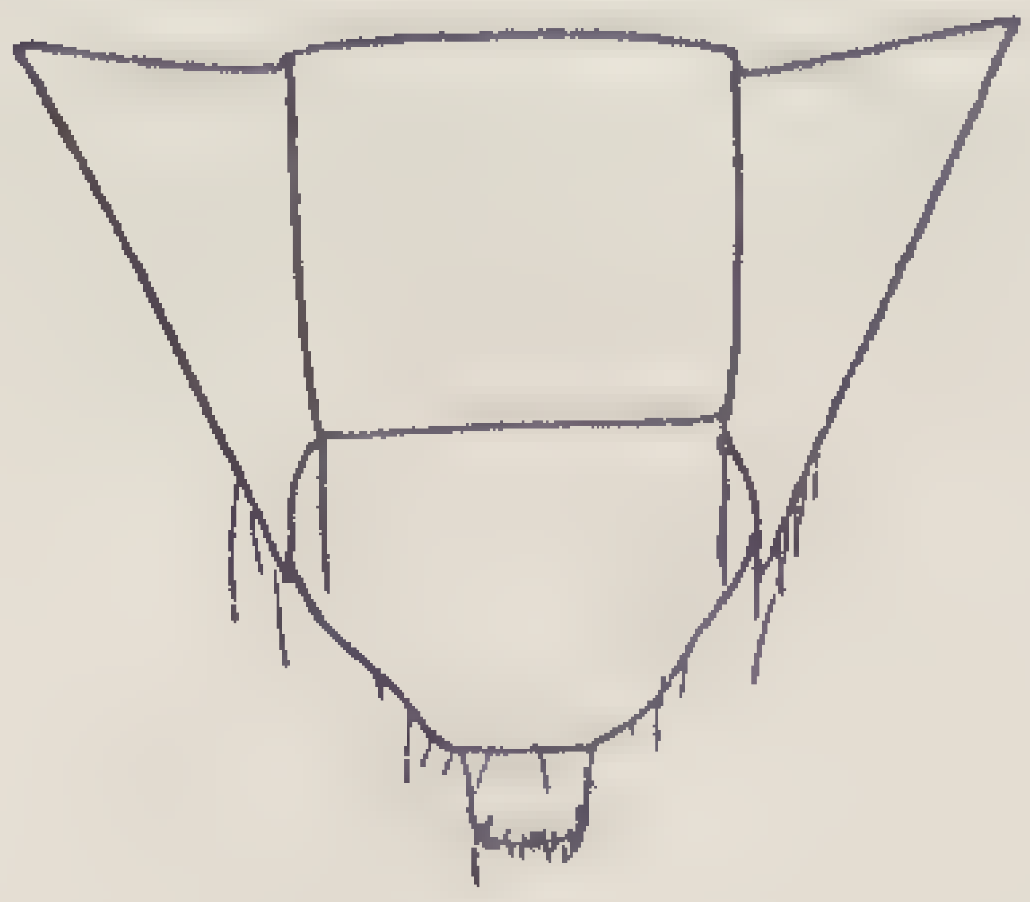
9a R. (N.) bisignata



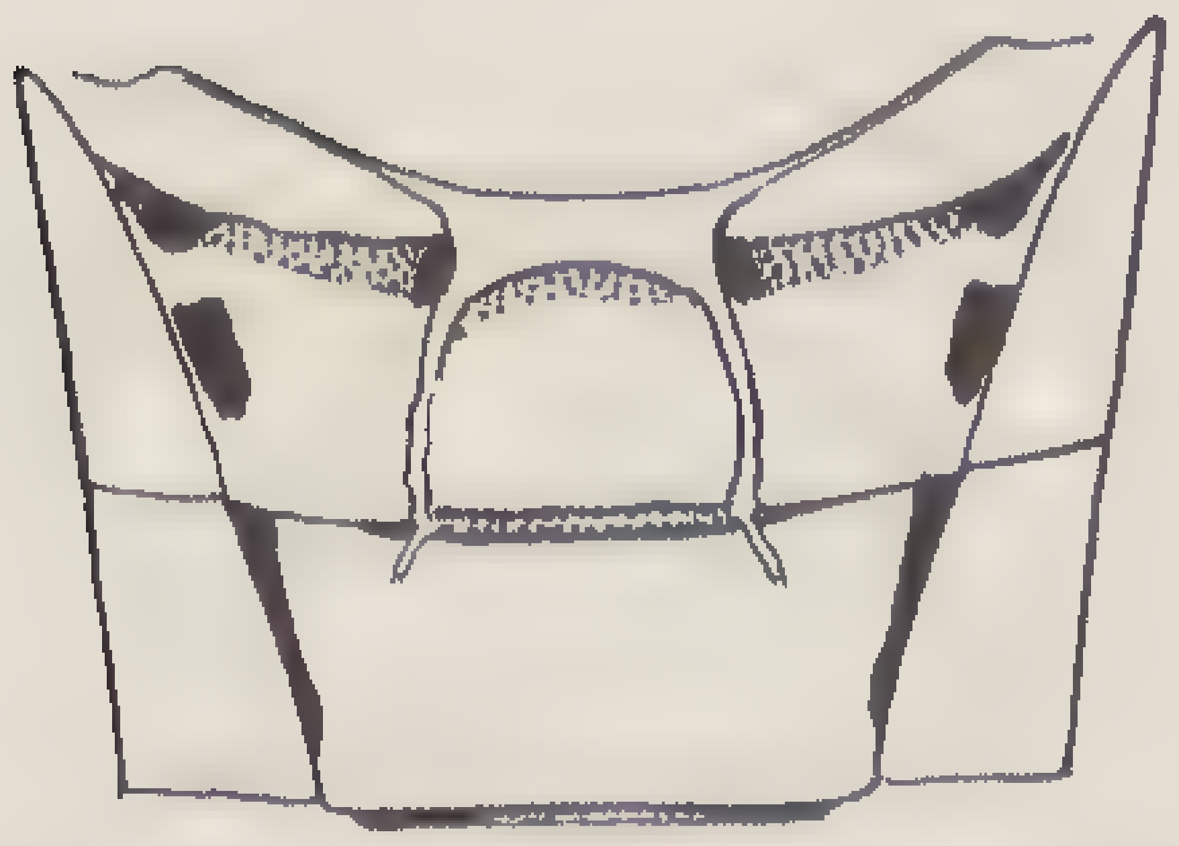
9b



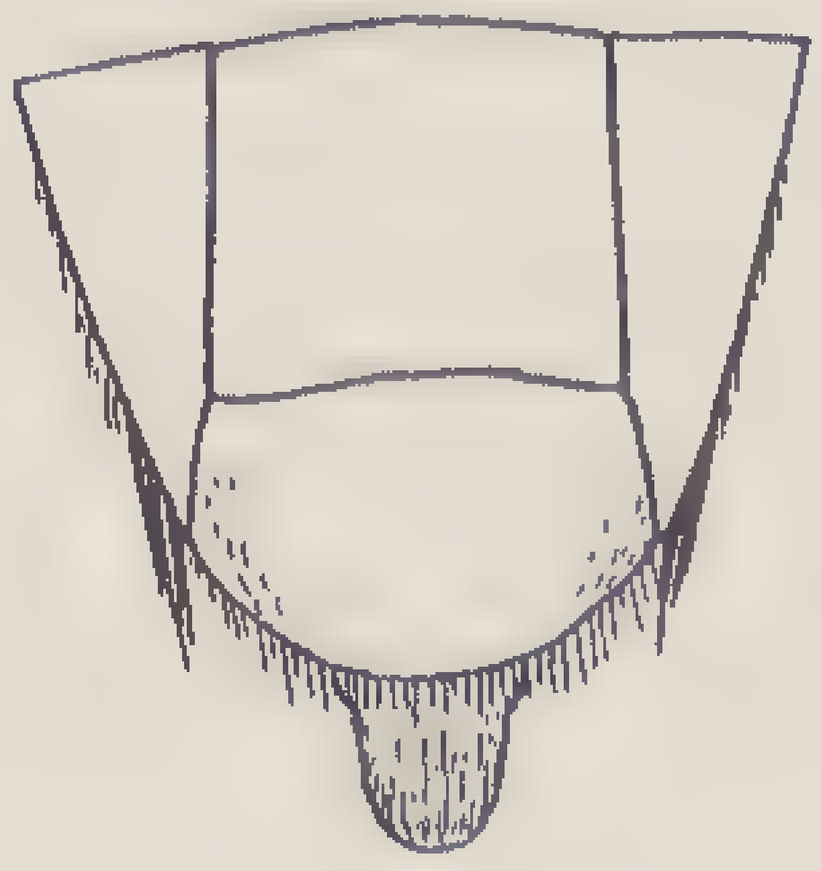
10a R. (N.) calopa



10 b



11a R.(N.) fontanalis



11b

PLATE 5

DORSAL VIEW OF ABDOMINAL SEGMENTS

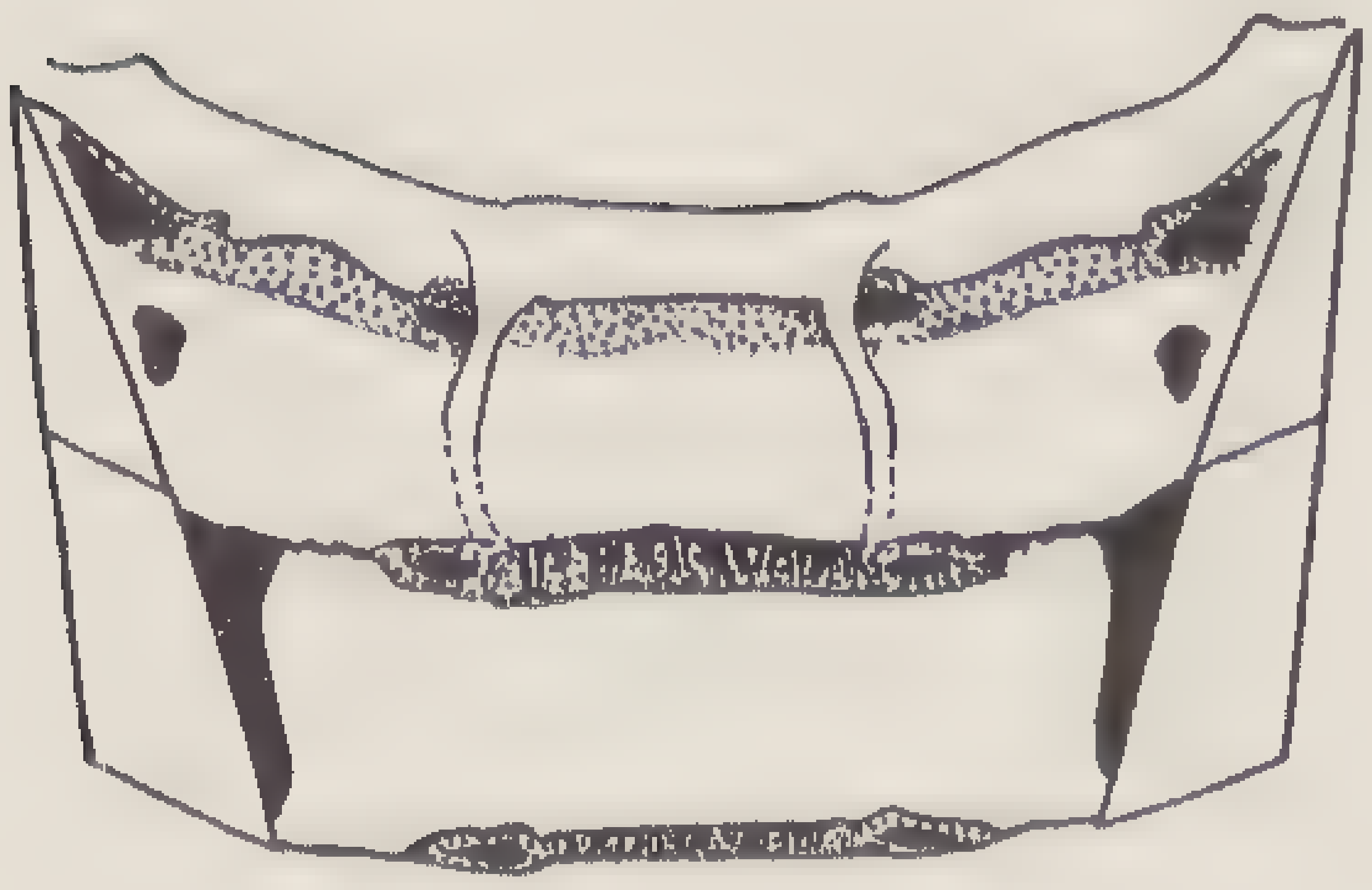
FIG. 12a. Basal segments of *Rhagovelia* (*Neorhagovelia*) *imitatrix* Bacon; 12b, apical segments of winged female.

FIG. 13a. Basal segments of *Rhagovelia* (*Neorhagovelia*) *longipes* Gould; 13b, apical segments of winged female.

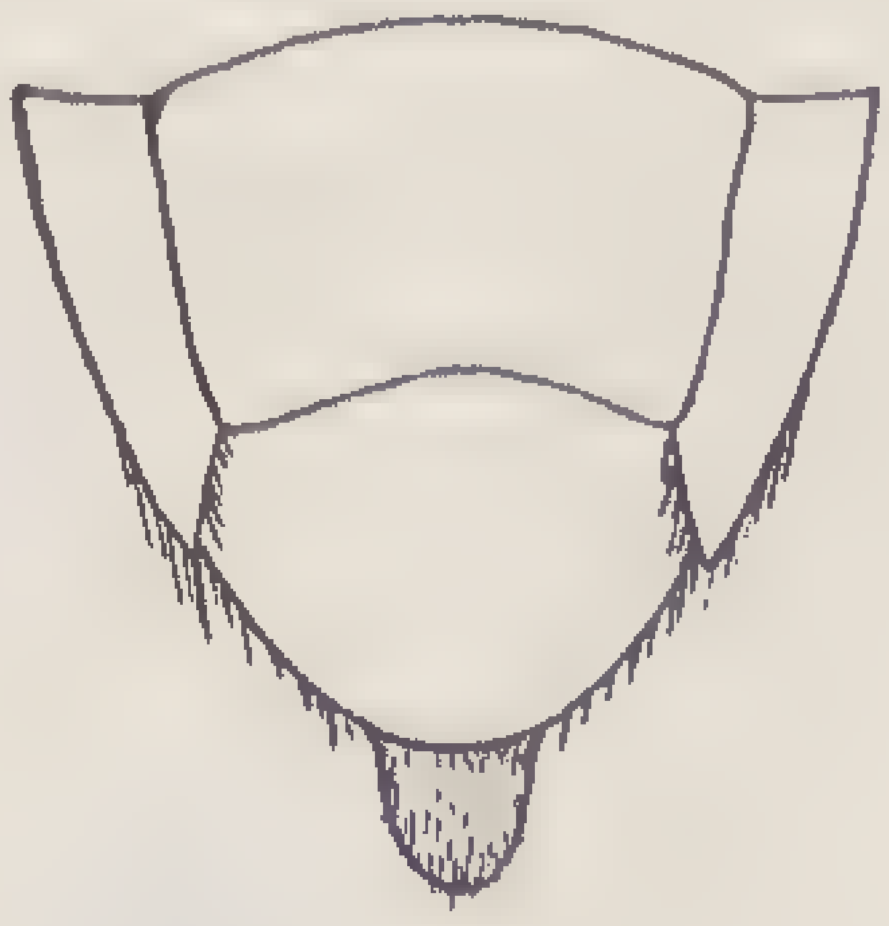
FIG. 14a. Basal segments of *Rhagovelia* (*Neorhagovelia*) *spinosa* Gould; 14b, apical segments of winged female.

FIG. 15a. Basal segments of *Rhagovelia* (*Neorhagovelia*) *tenuipes* Champion; 15b, apical segments of winged female.

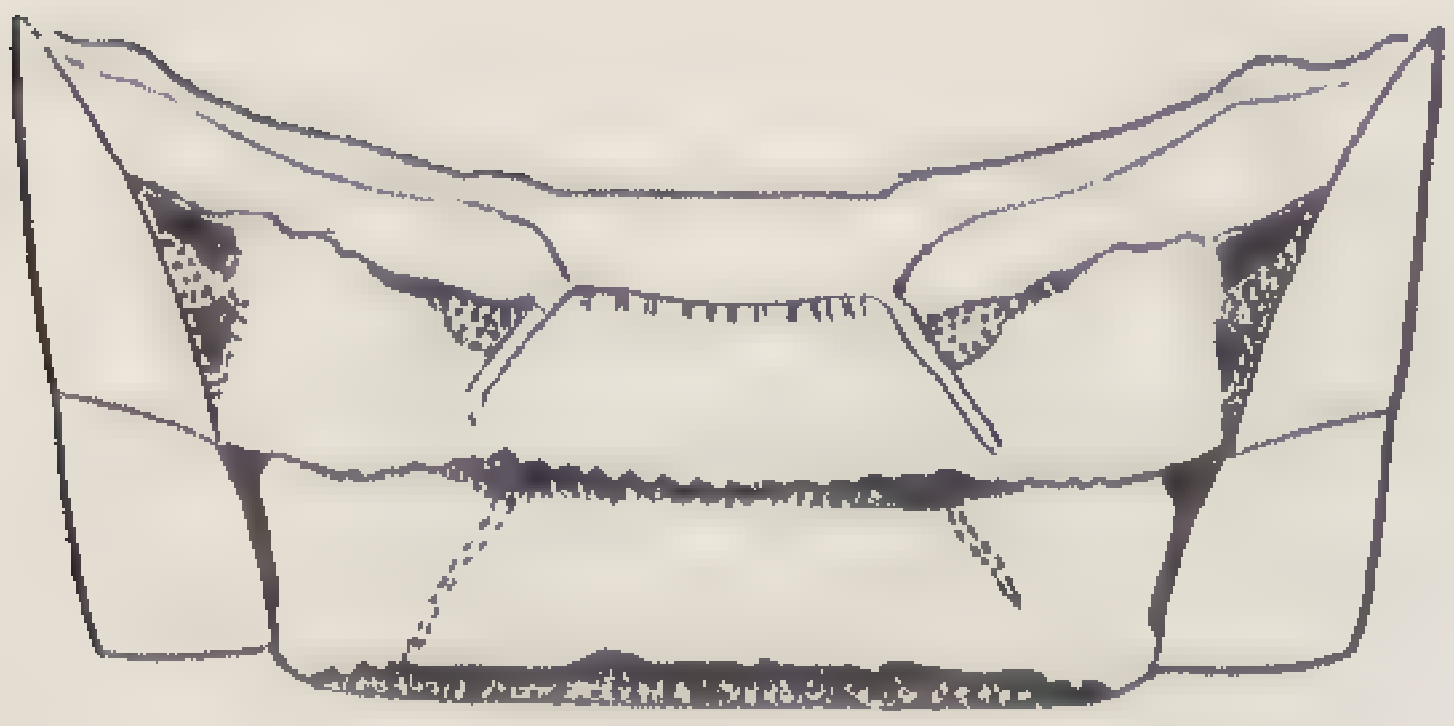
PLATE 5



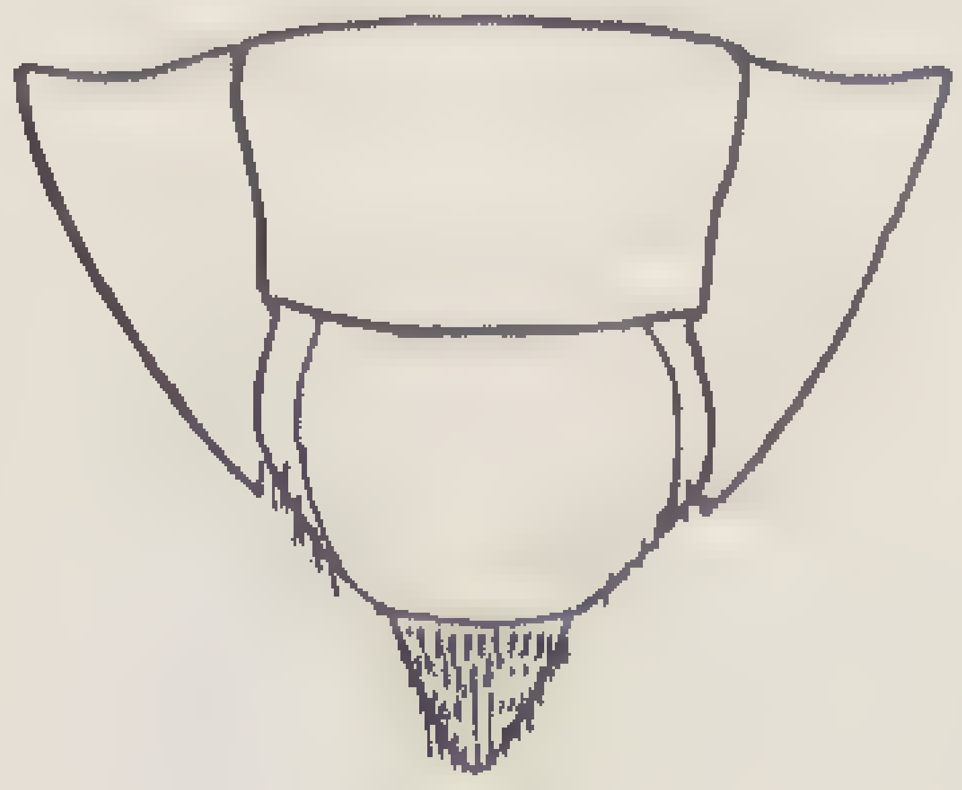
12a R.(N.) imitatrix



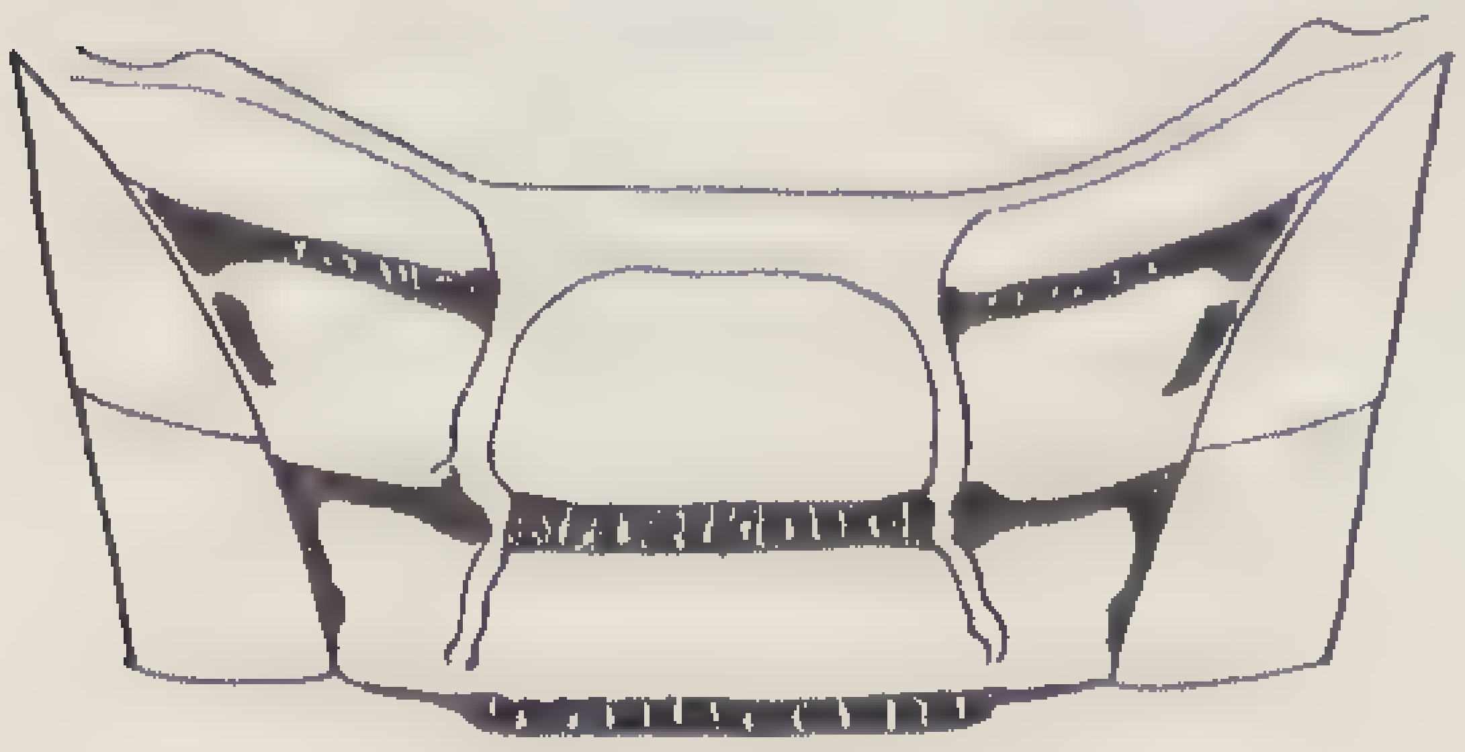
12b



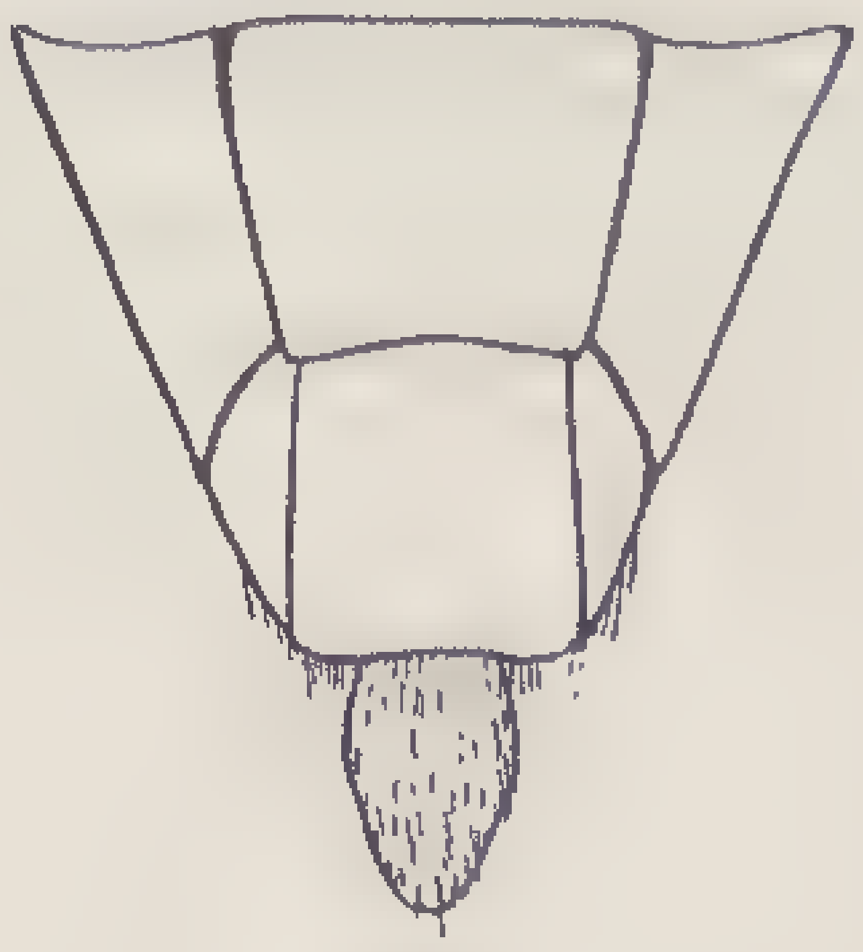
13a R.(N.) longipes



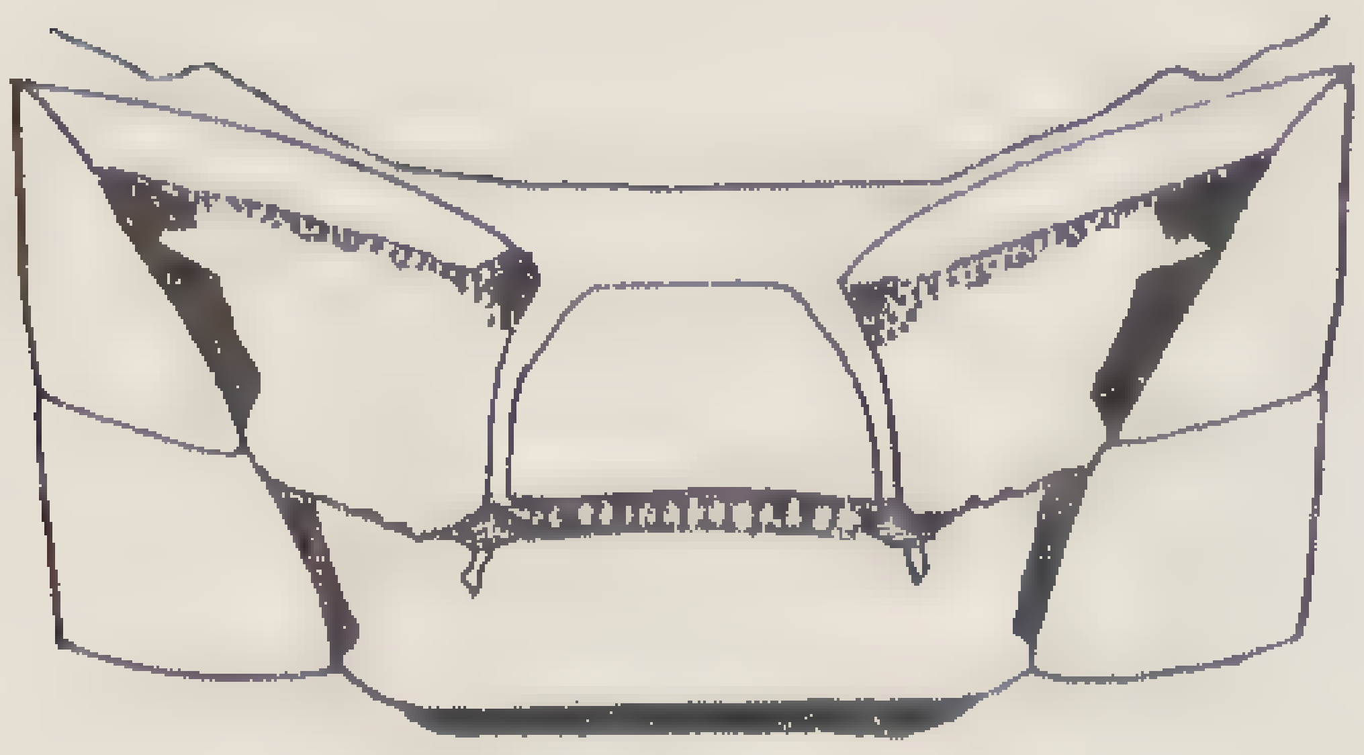
13b



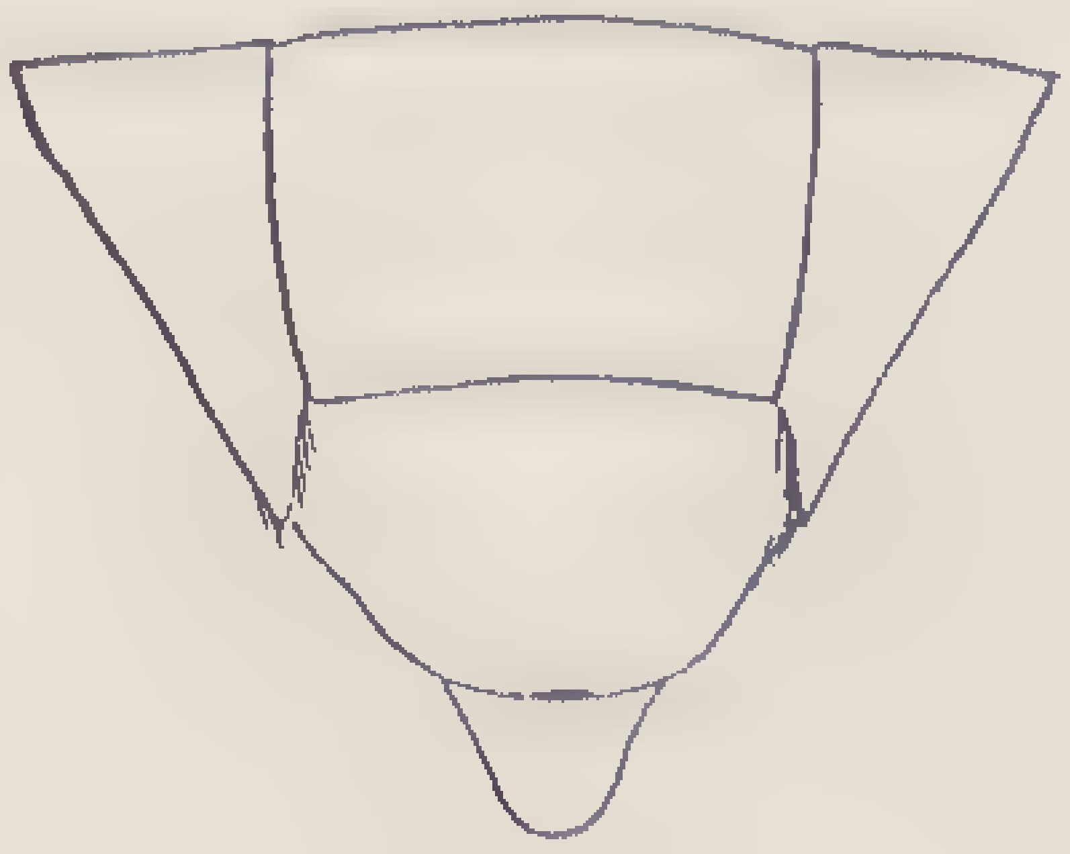
14a R.(N.) spinosa



14b



15a R.(N.) tenuipes



15b

PLATE 6

DORSAL VIEW OF ABDOMINAL SEGMENTS

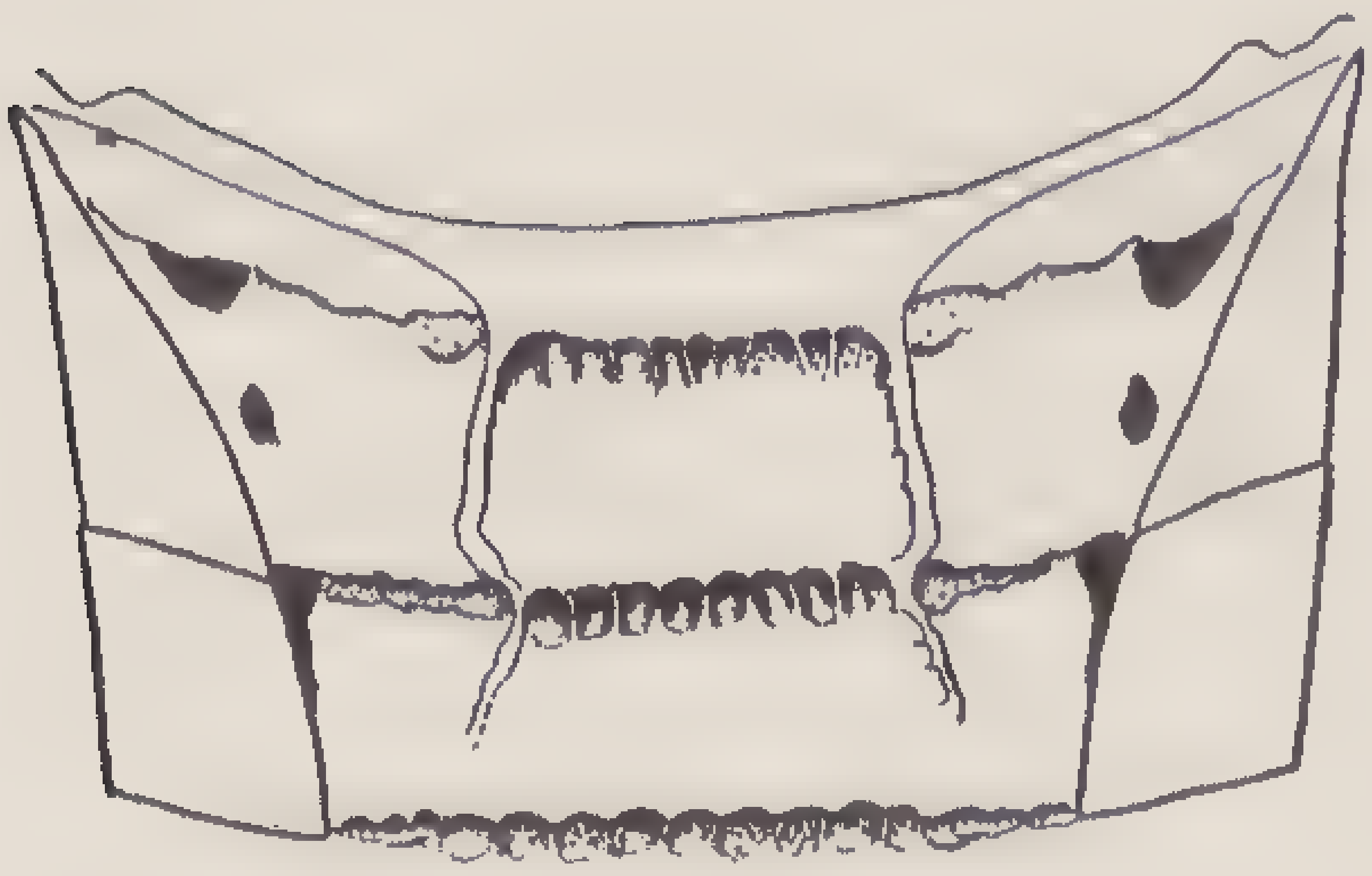
FIG. 16a. Basal segments of *Rhagovelia* (*Neorhagovelia*) *versuta* Drake and Harris; 16b, apical segments of winged female.

FIG. 17a. Basal segments of *Rhagovelia* (*Neorhagovelia*) *tantilla* Drake and Harris; 17b, apical segments of winged female.

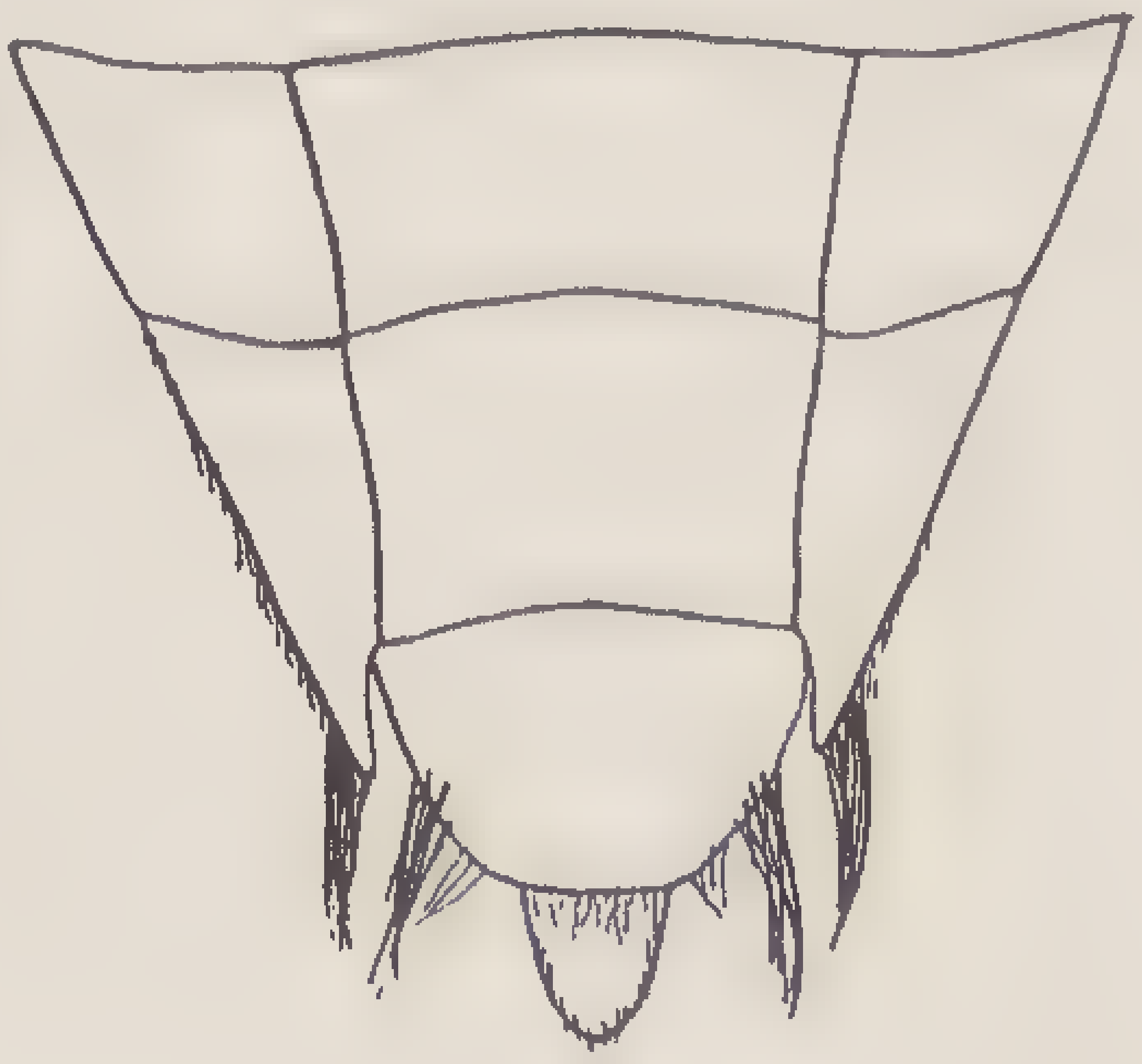
FIG. 18a. Basal segments of *Rhagovelia* (*Neorhagovelia*) *paulana* Drake; 18b, apical segments of winged female.

FIG. 19a. Basal segments of *Rhagovelia* (*Neorhagovelia*) *janeira* Drake; 19b, apical segments of winged female.

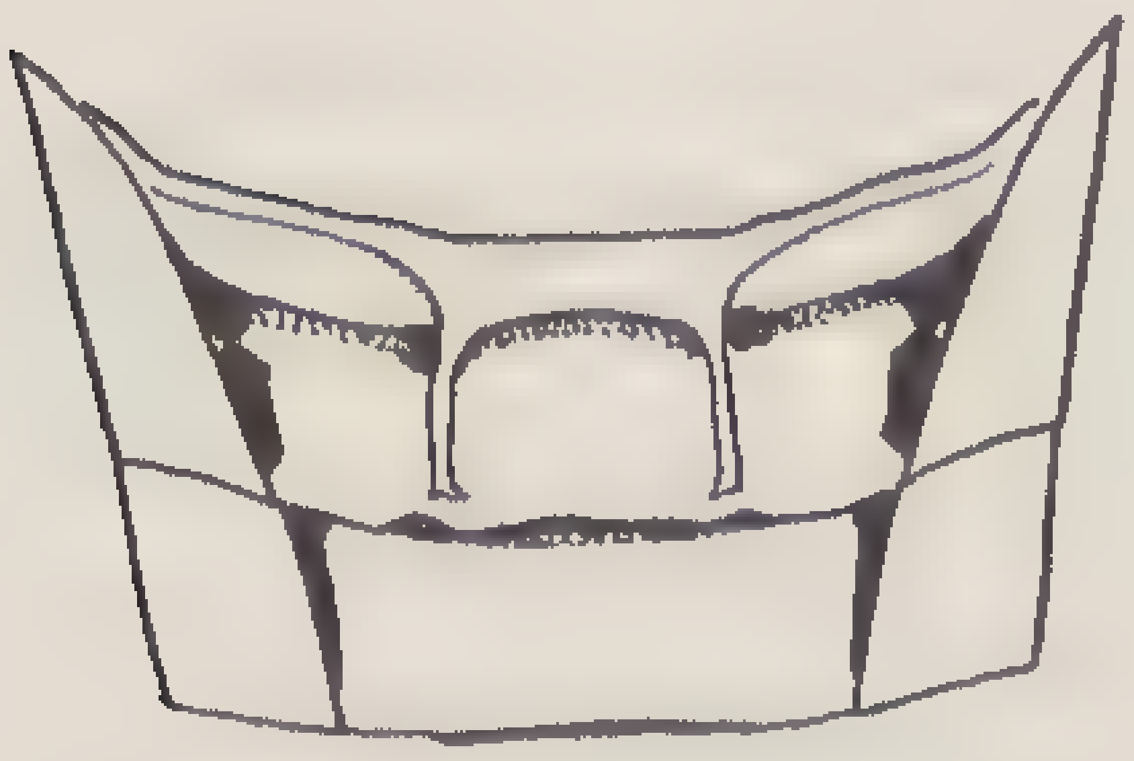
PLATE 6



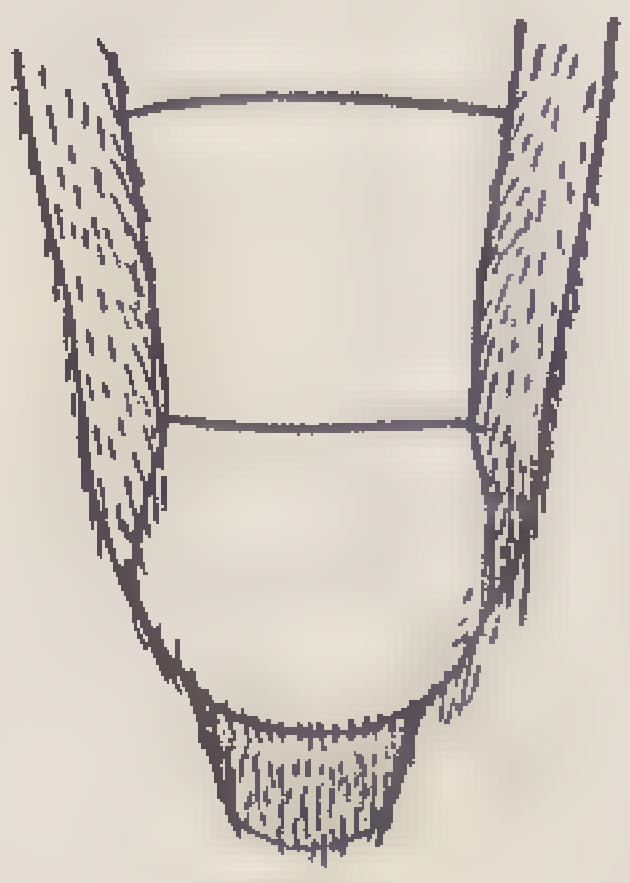
16a R.(N.) versuta



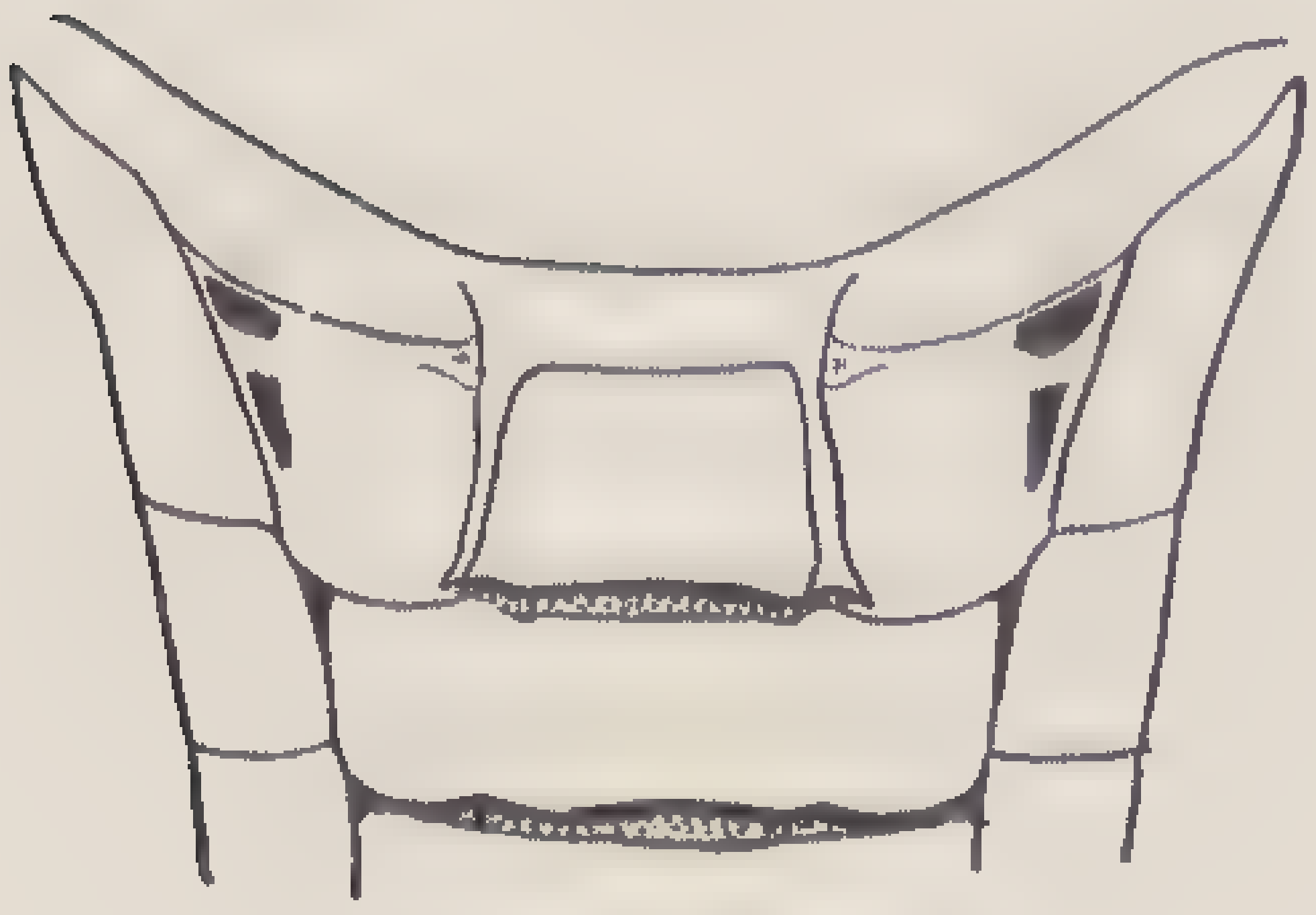
16b



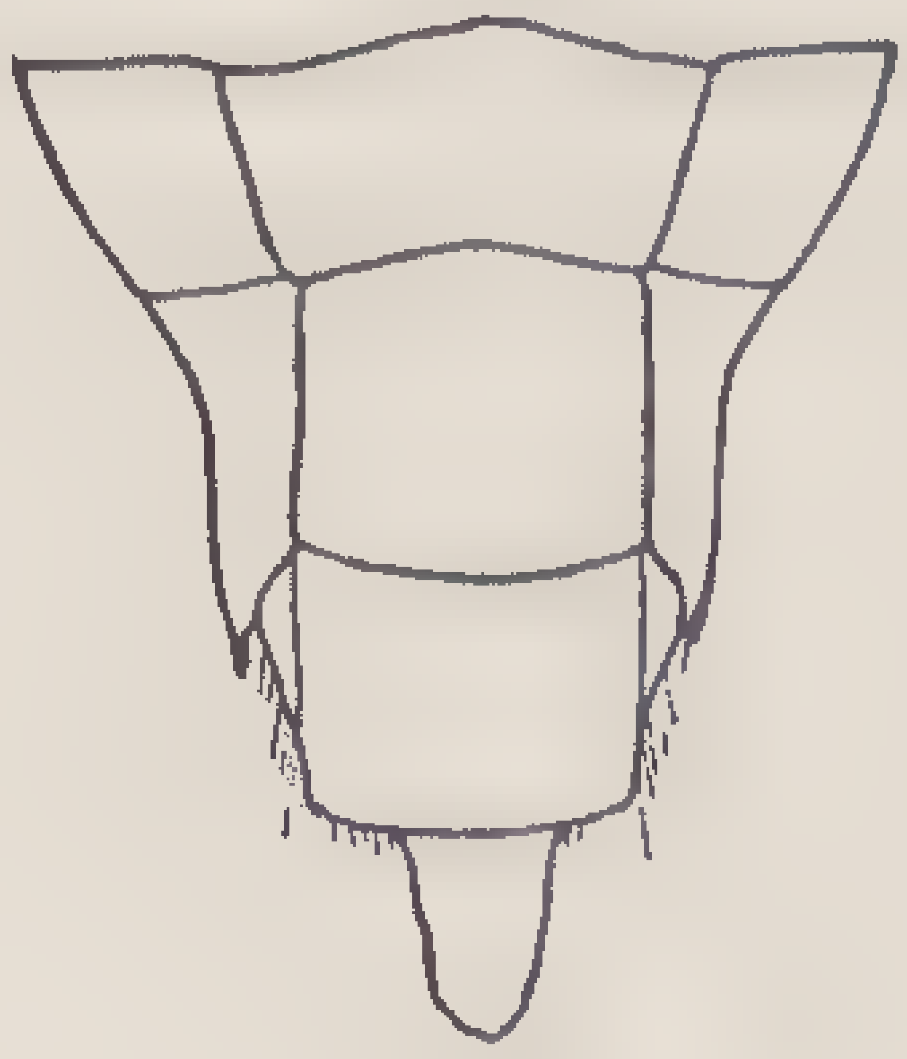
17a R.(N.) tantilla



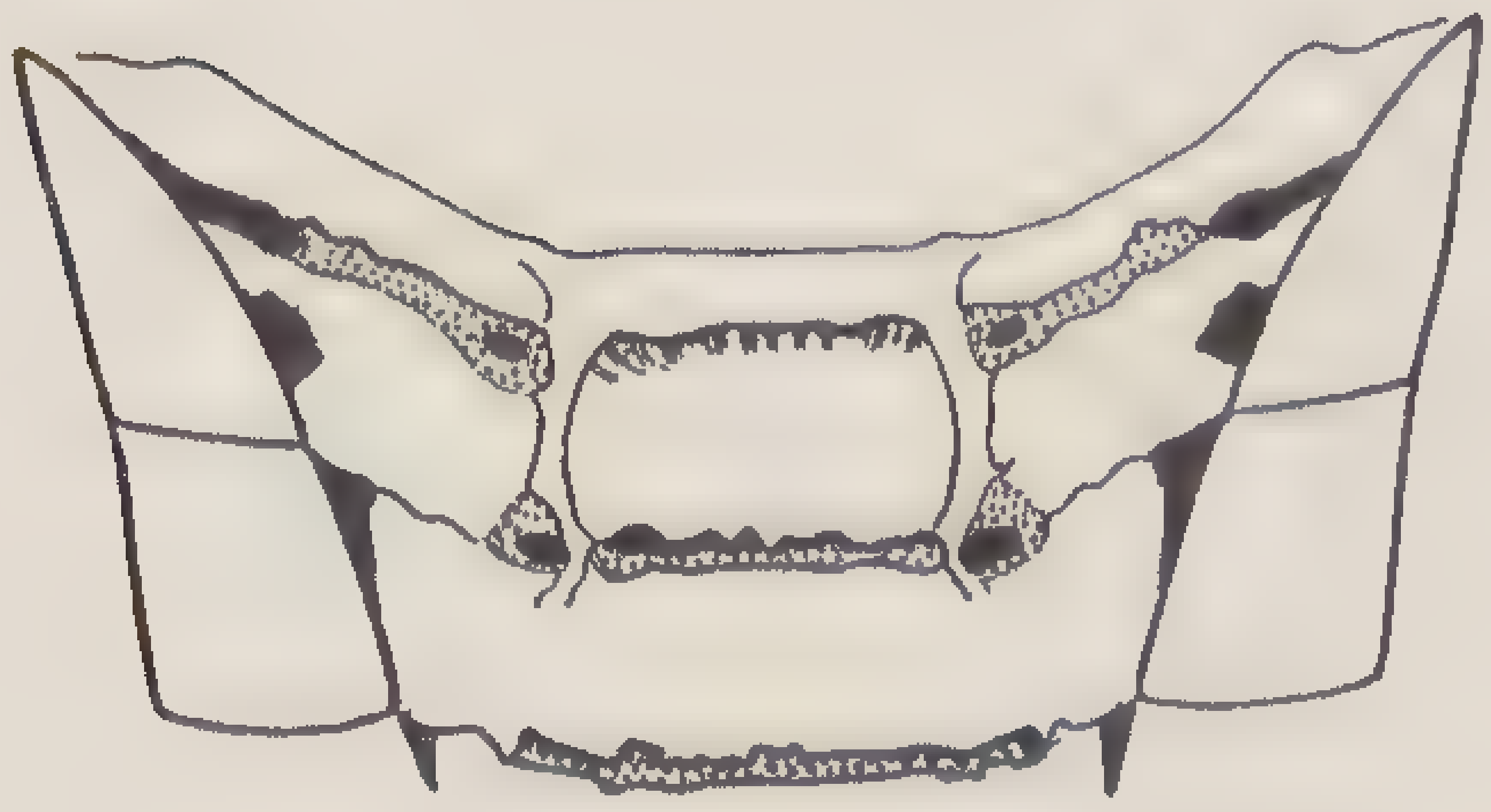
17b



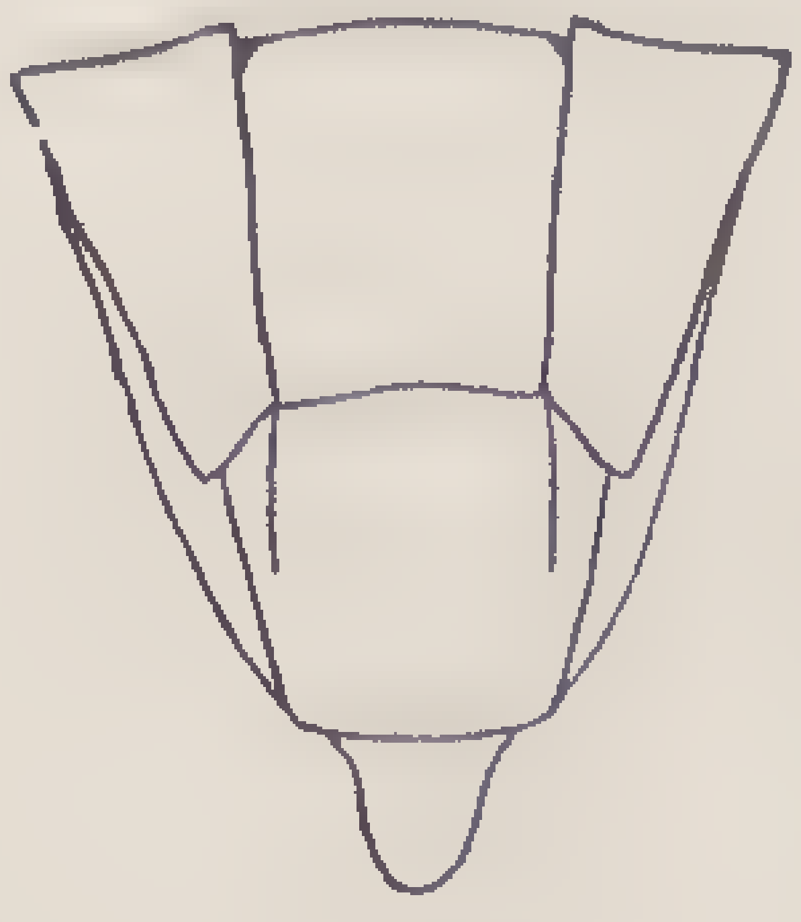
18a R(N.) paulana



18b



19a R.(N.) janeira



19b

PLATE 7

DORSAL VIEW OF ABDOMINAL SEGMENTS

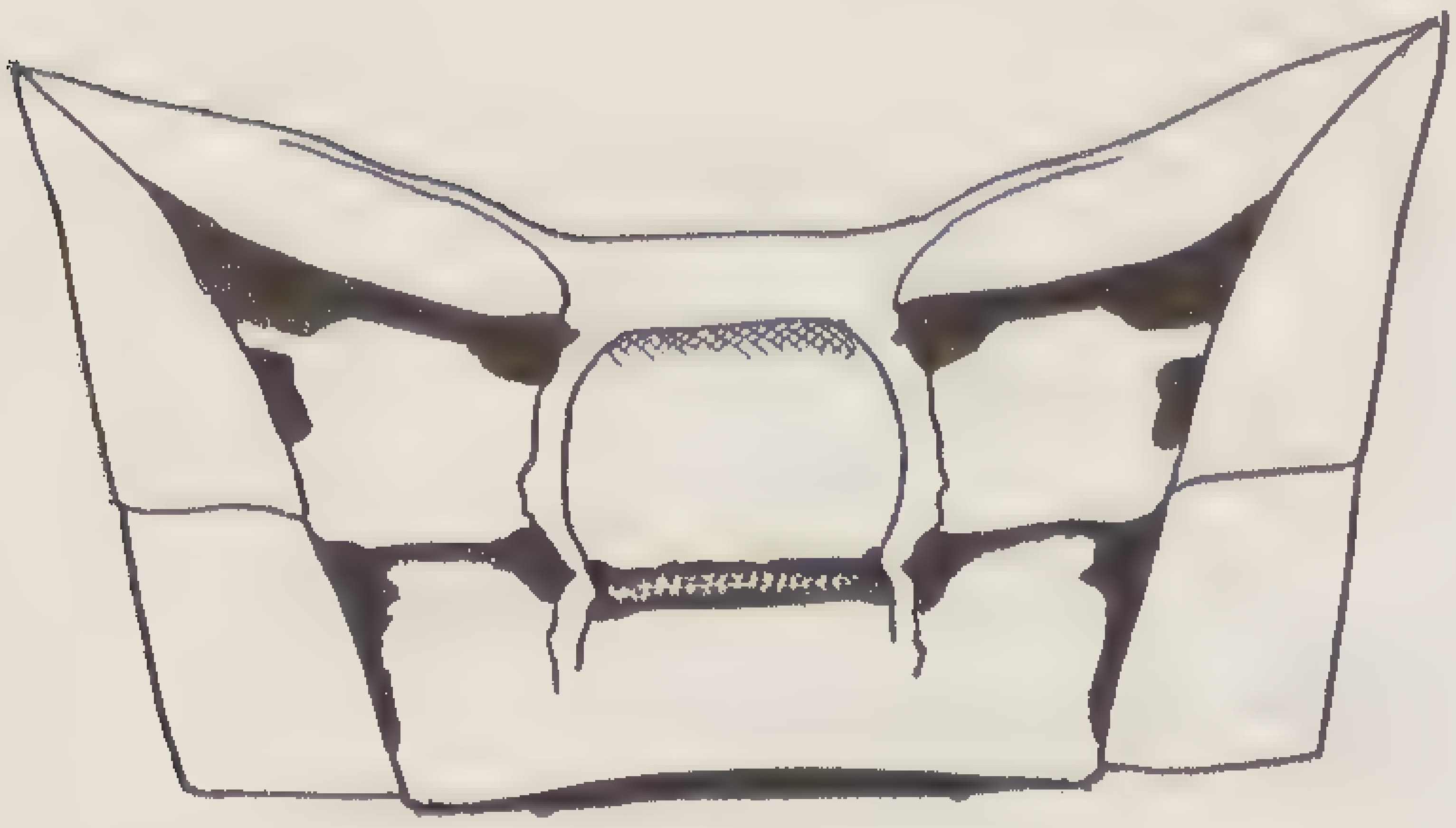
FIG. 20a. Basal segments of *Rhagovelia* (*Neorhagovelia*) *abrupta* Gould; 20b, apical segments of winged female.

FIG. 21a. Basal segments of *Rhagovelia* (*Neorhagovelia*) *vivata* Bacon; 21b, apical segments of winged female.

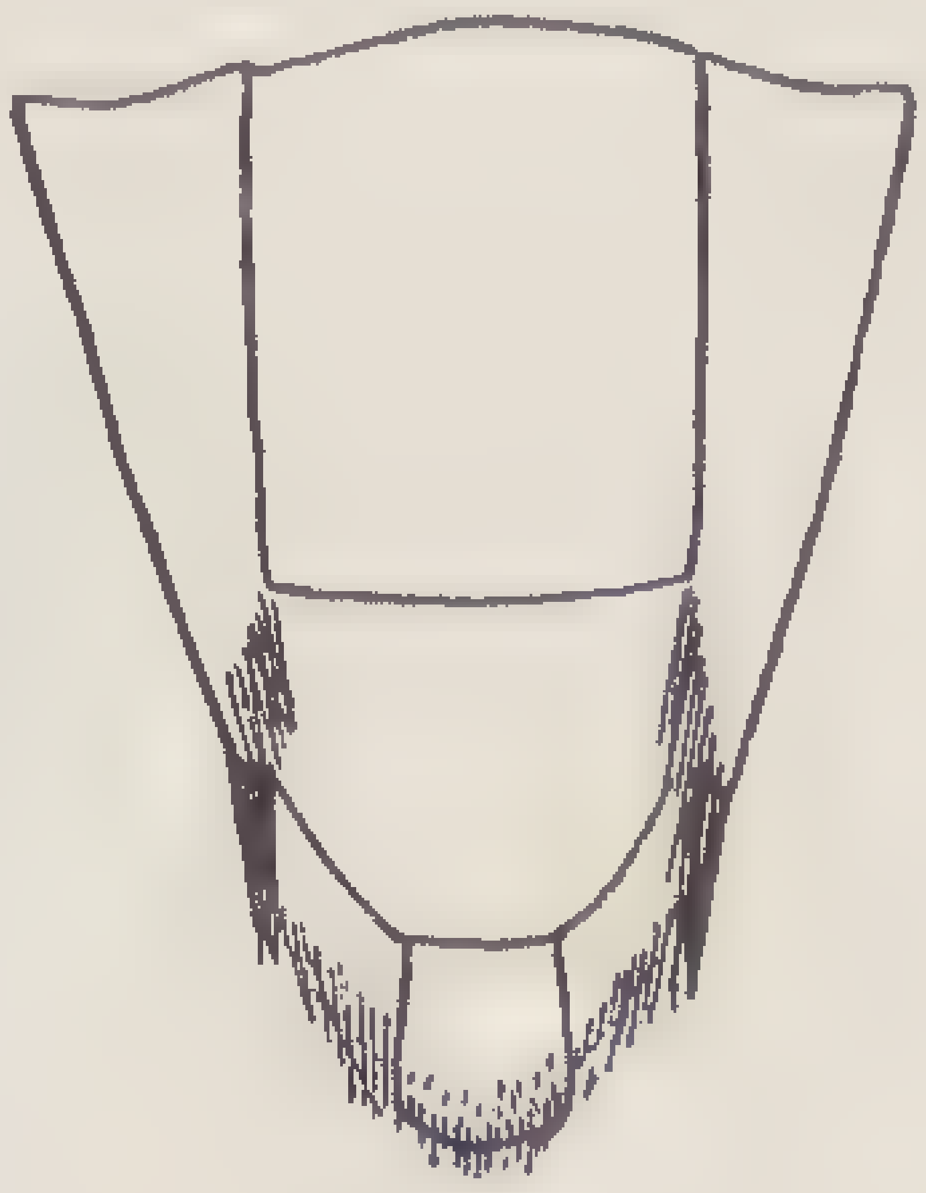
FIG. 22a. Basal segments of *Rhagovelia* (*Neorhagovelia*) *trista* Gould; 22b, apical segments of winged female.

FIG. 23a. Basal segments of *Rhagovelia hirtipes* Drake and Harris; 23b, apical segments of winged female.

PLATE 7



20a R.(N.) abrupta



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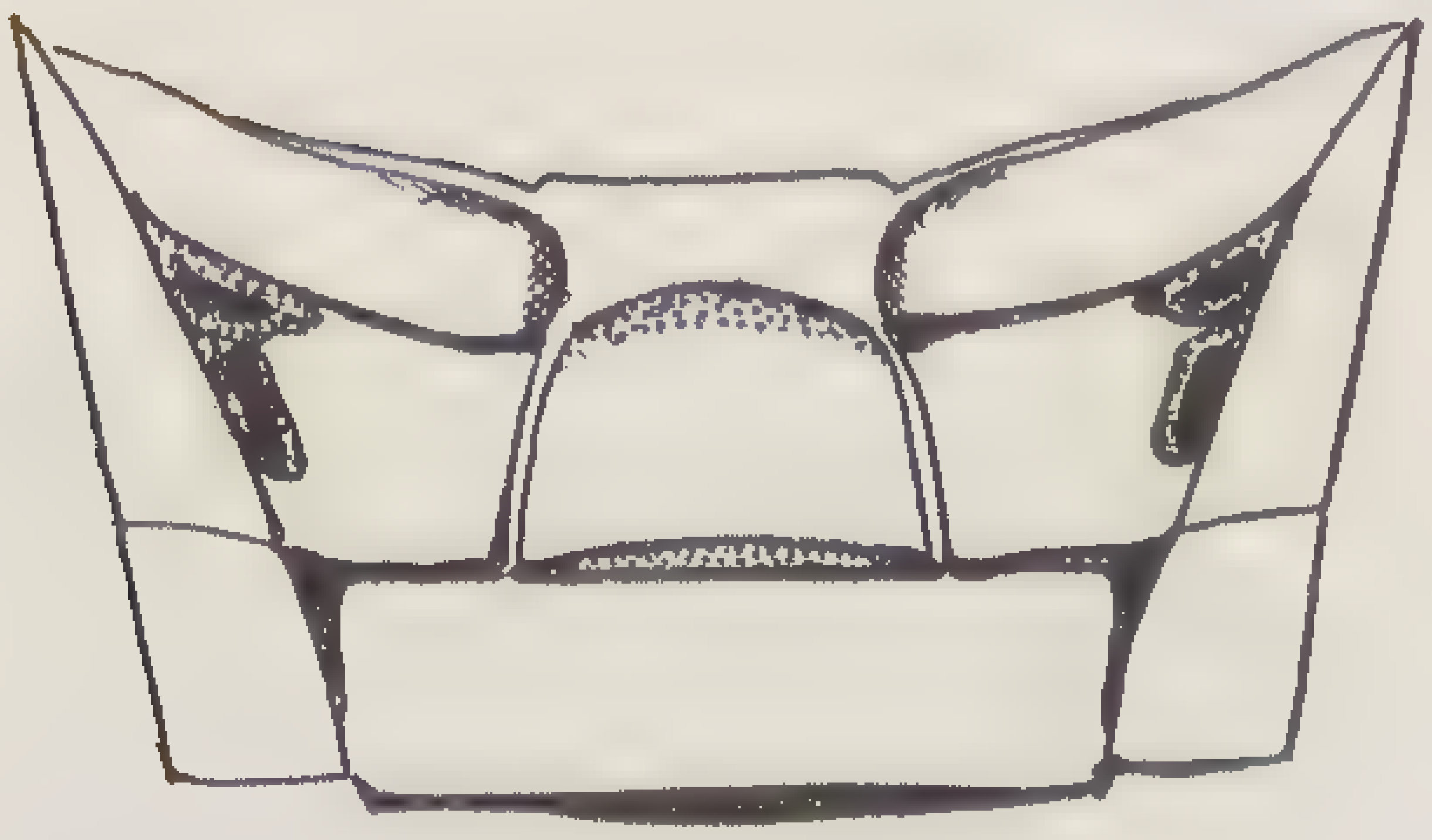
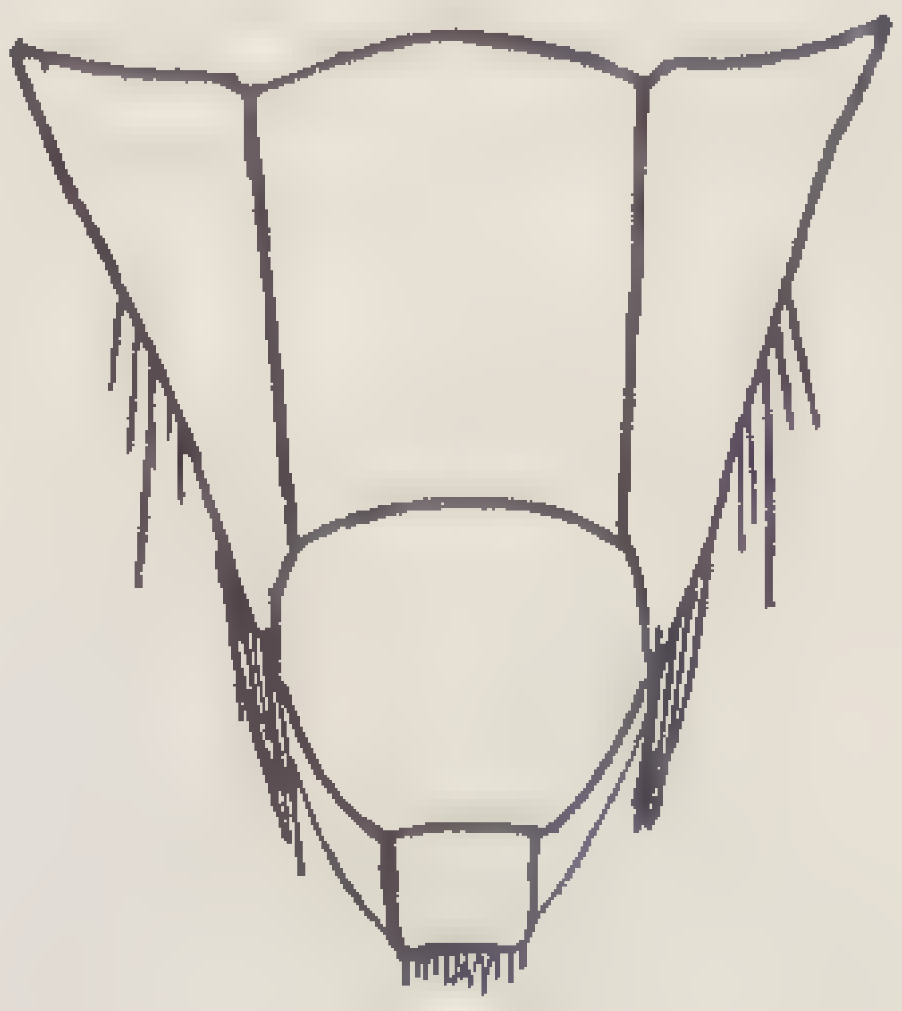
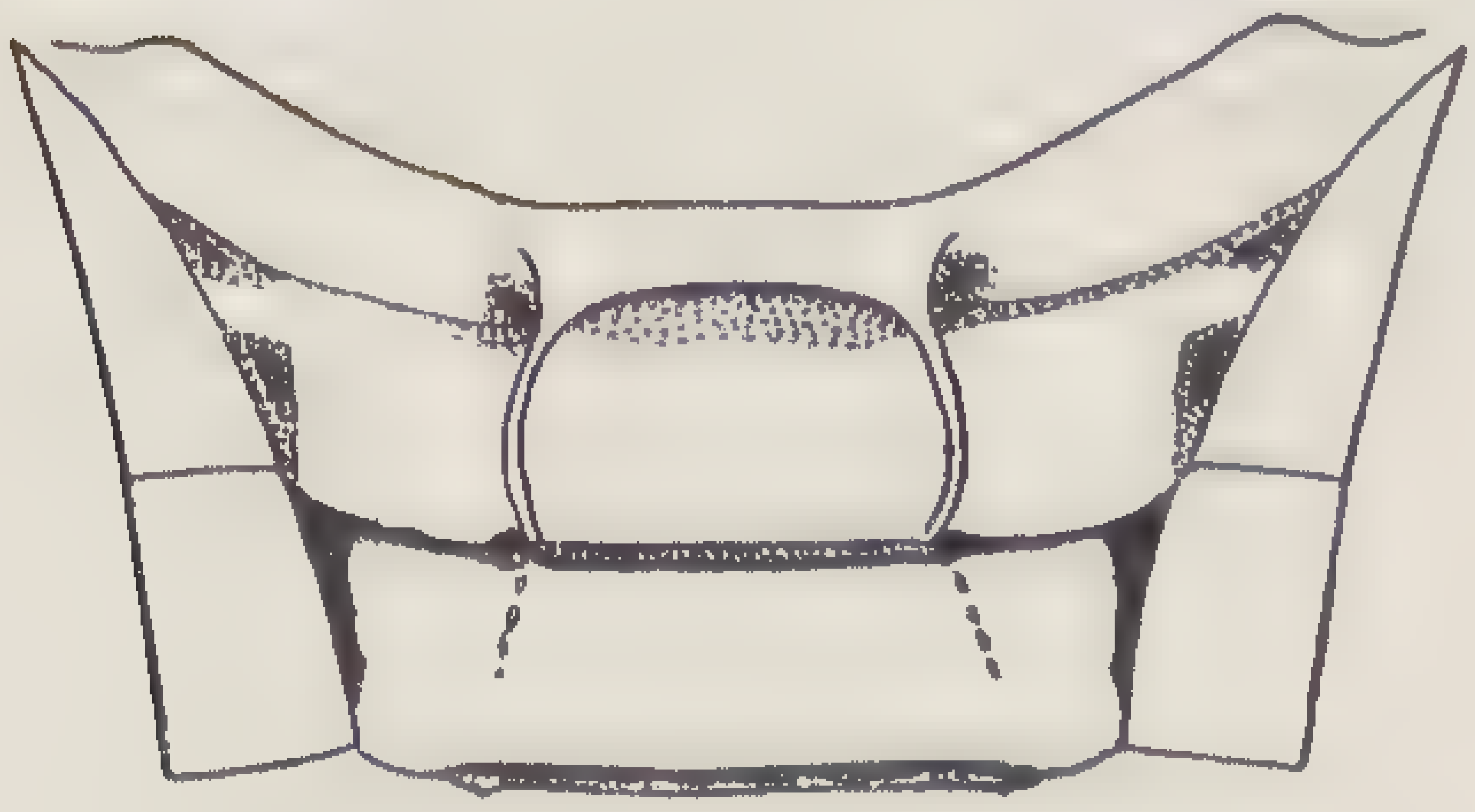


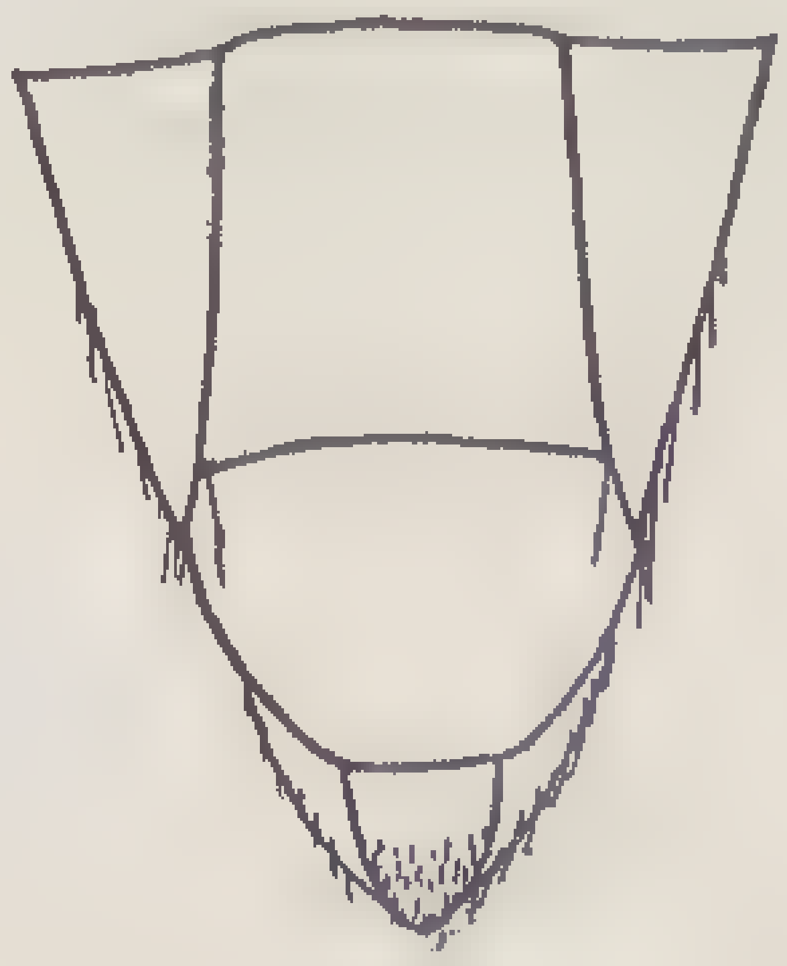
21a R.(N.) vivata



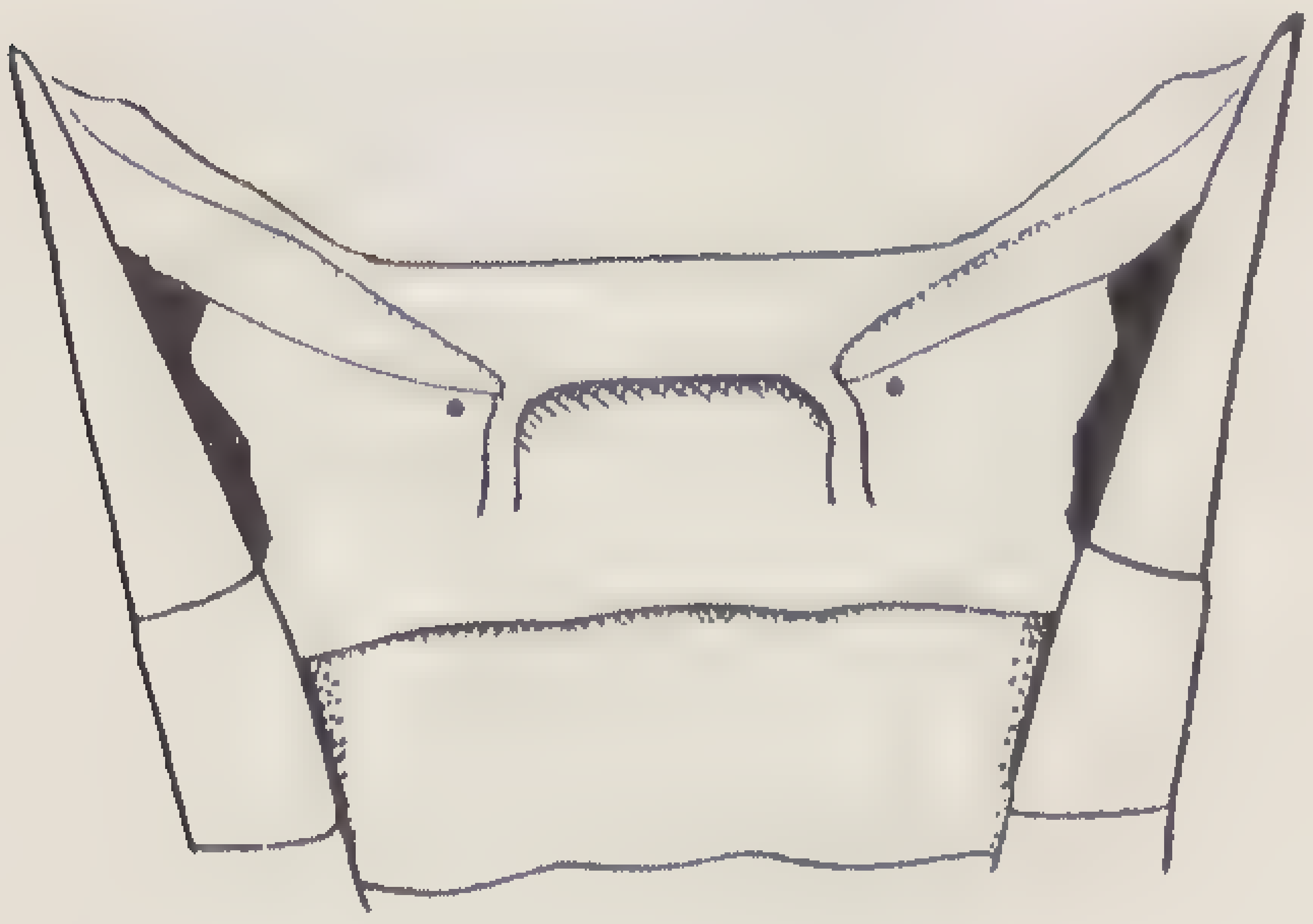
21b



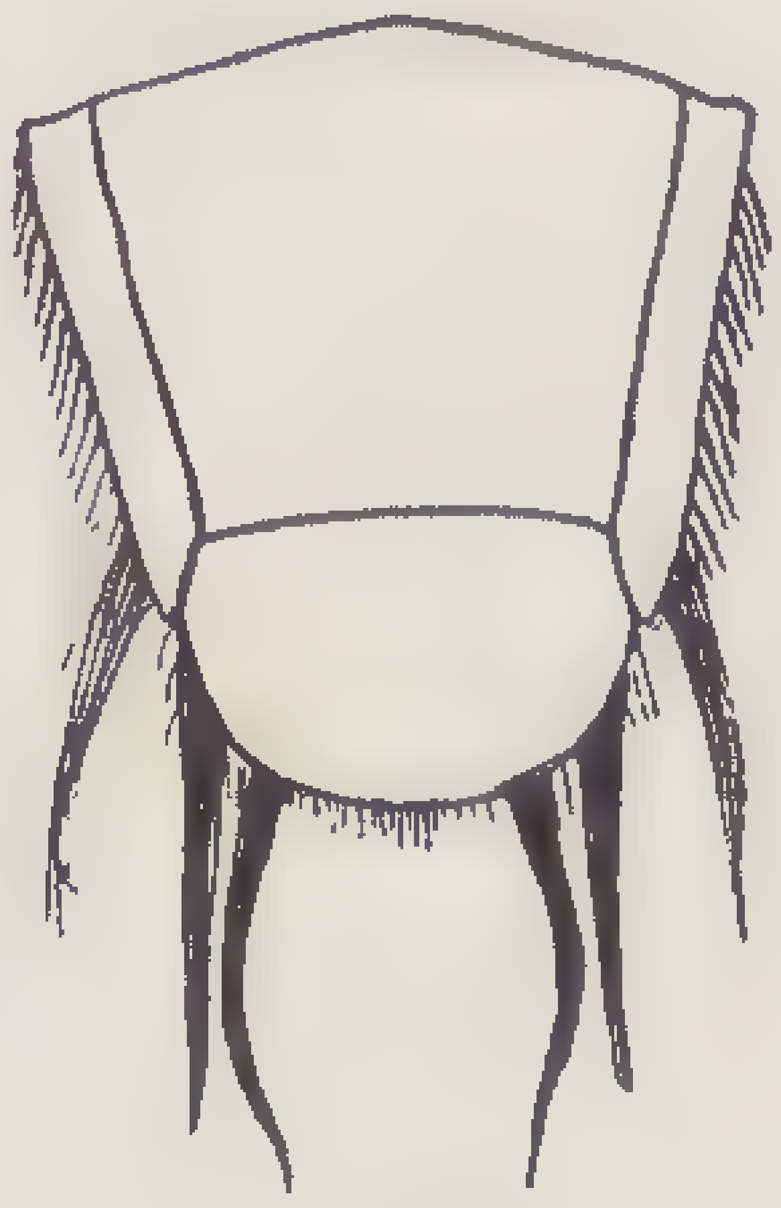
22a R.(N.) trista



22b



23a R. hirtipes



23b

PLATE 8

DORSAL VIEW OF ABDOMINAL SEGMENTS

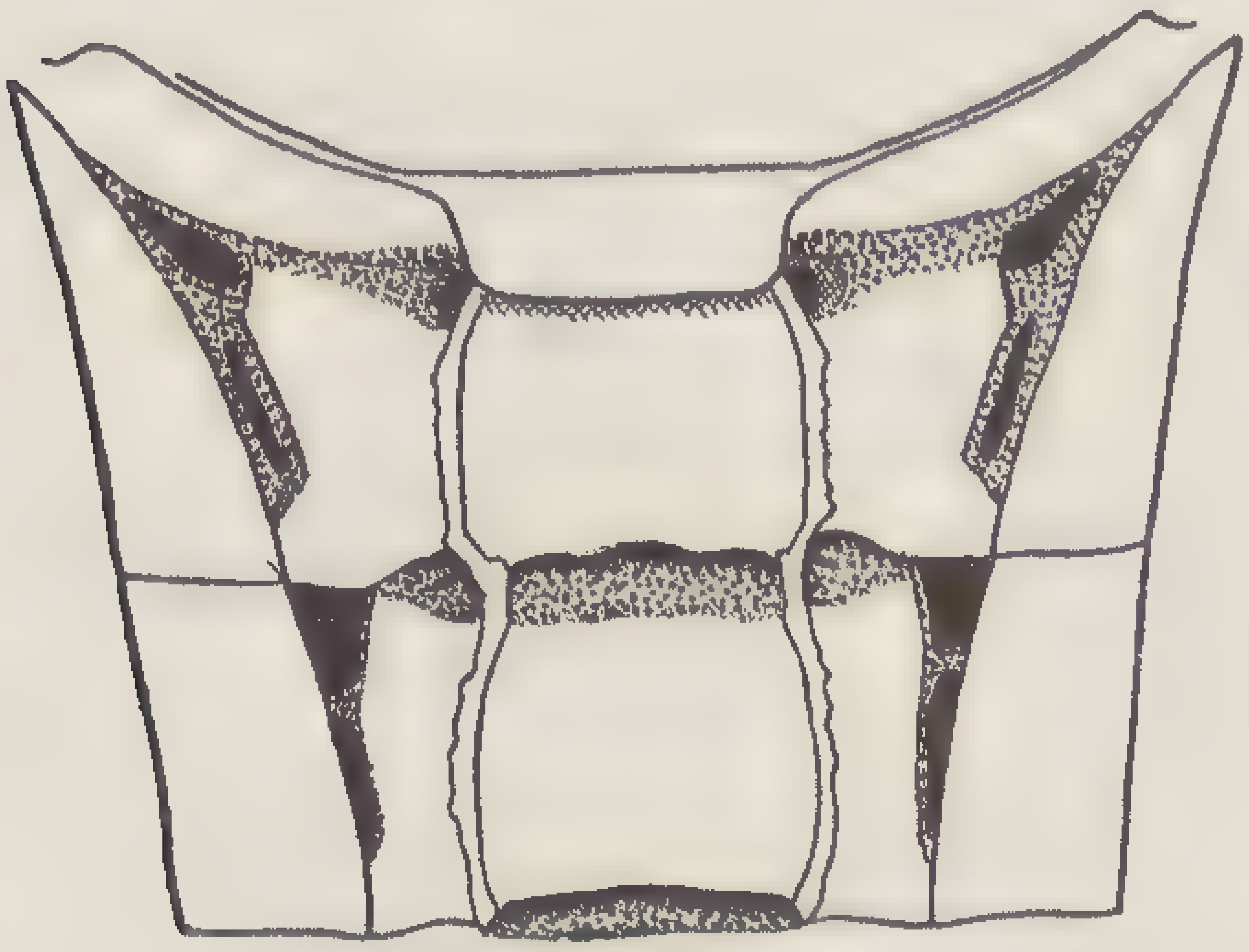
FIG. 24. Basal segments of *Rhagovelia* (*Rhagovelia*) *scabra* Bacon.

FIG. 25a. Basal segments of *Rhagovelia* (*Rhagovelia*) *elegans* Uhler; 25b, apical segments of winged female.

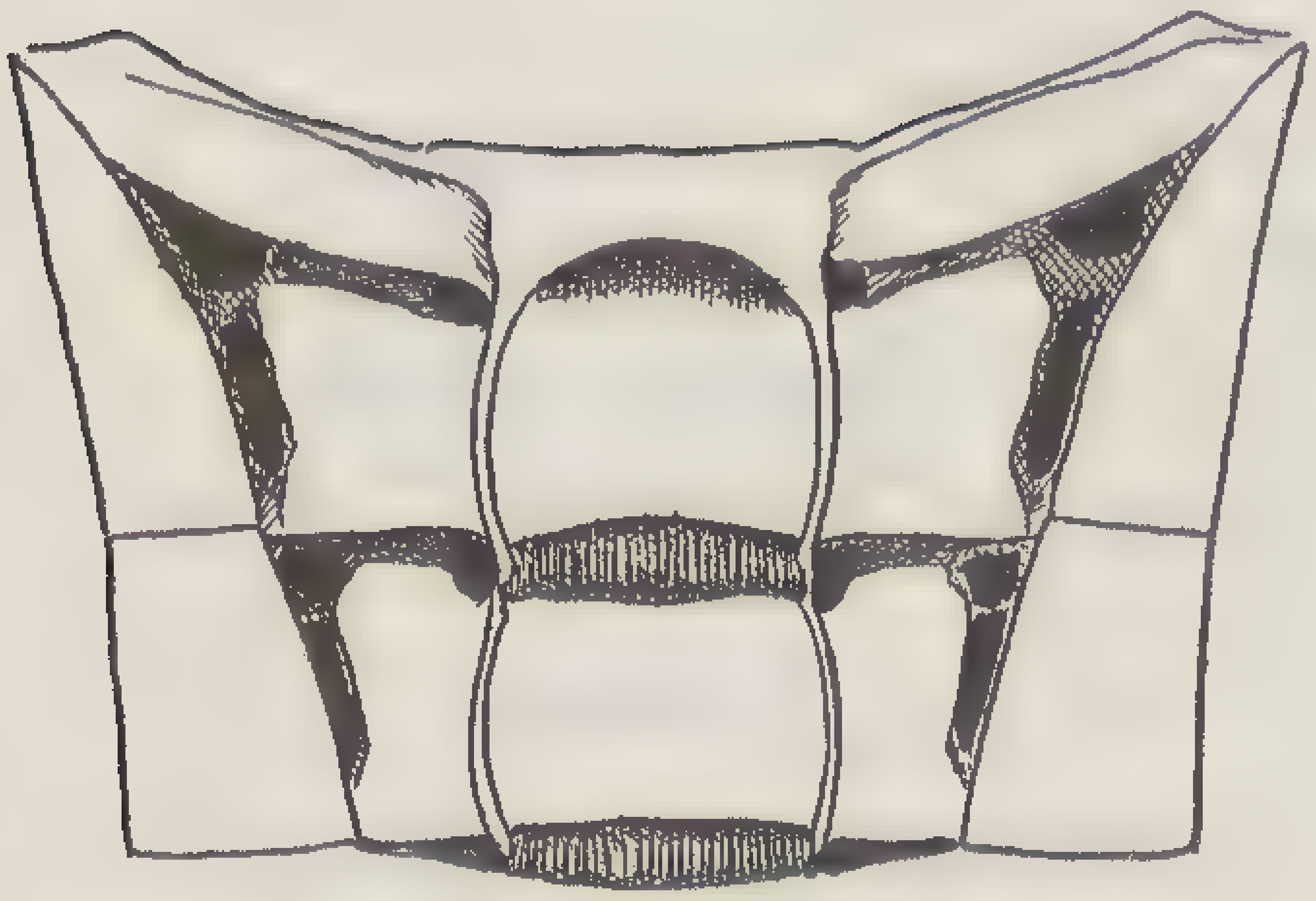
FIG. 26a. Basal segments of *Rhagovelia* (*Rhagovelia*) *uncinata* Champion; 26b, apical segments of winged female.

FIG. 27a. Basal segments of *Rhagovelia* (*Rhagovelia*) *insularis* Champion; 27b, apical segments of winged female.

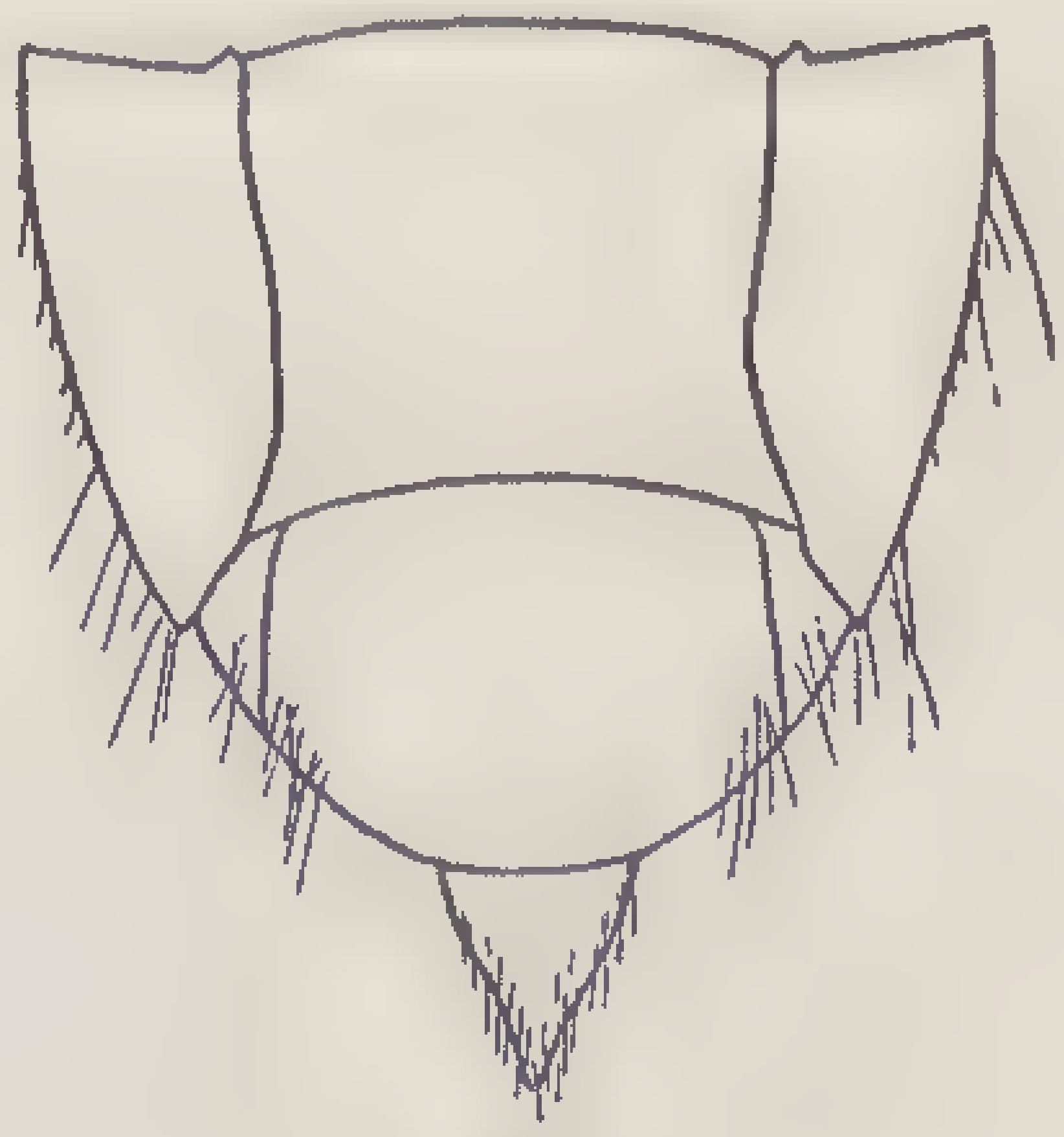
PLATE 8



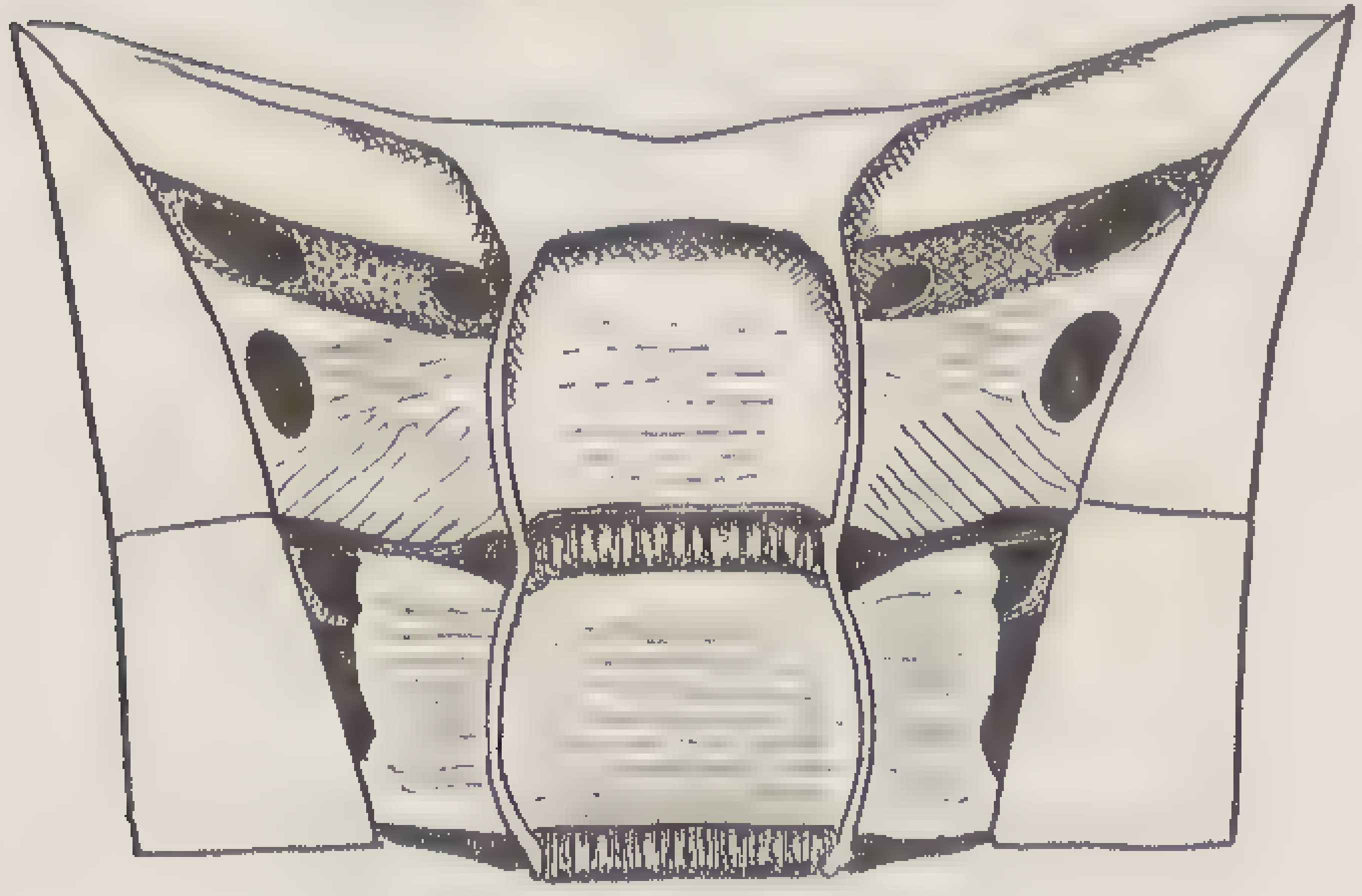
24 R.(R.) scabra



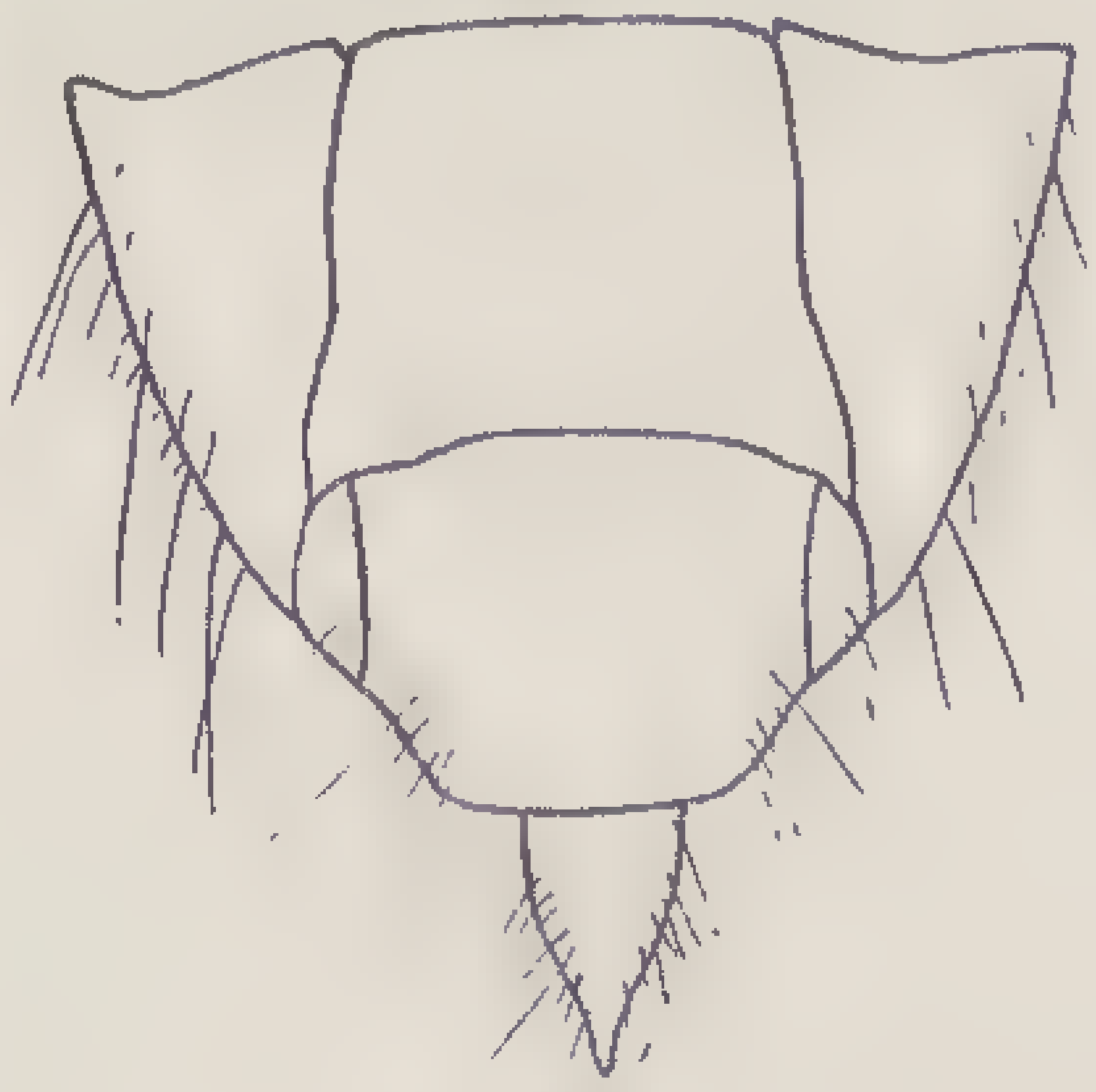
25a R.(R.) elegans



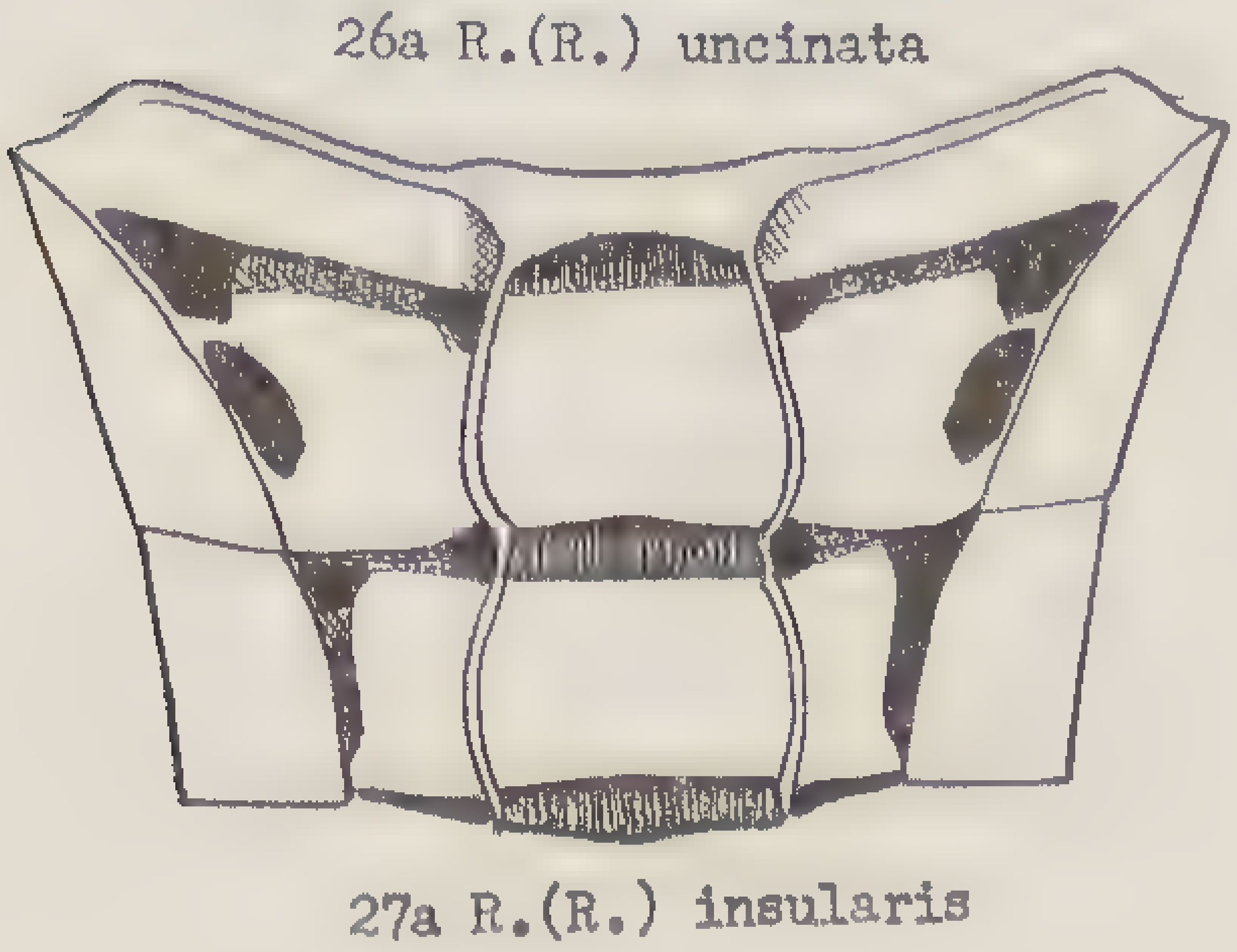
25b



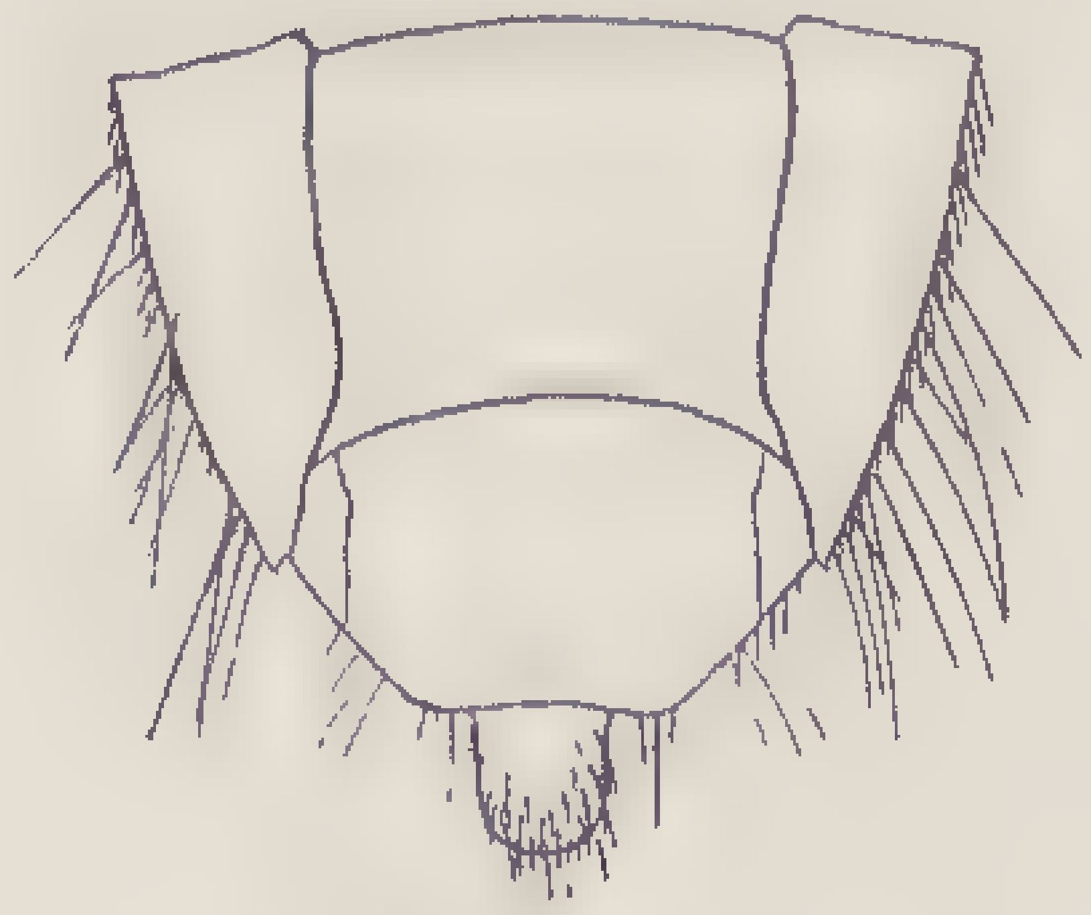
26a R.(R.) uncinata



26b



27a R.(R.) insularis



27b

PLATE 9

DORSAL VIEW OF ABDOMINAL SEGMENTS AND LATERAL VIEW OF PRONOTUM

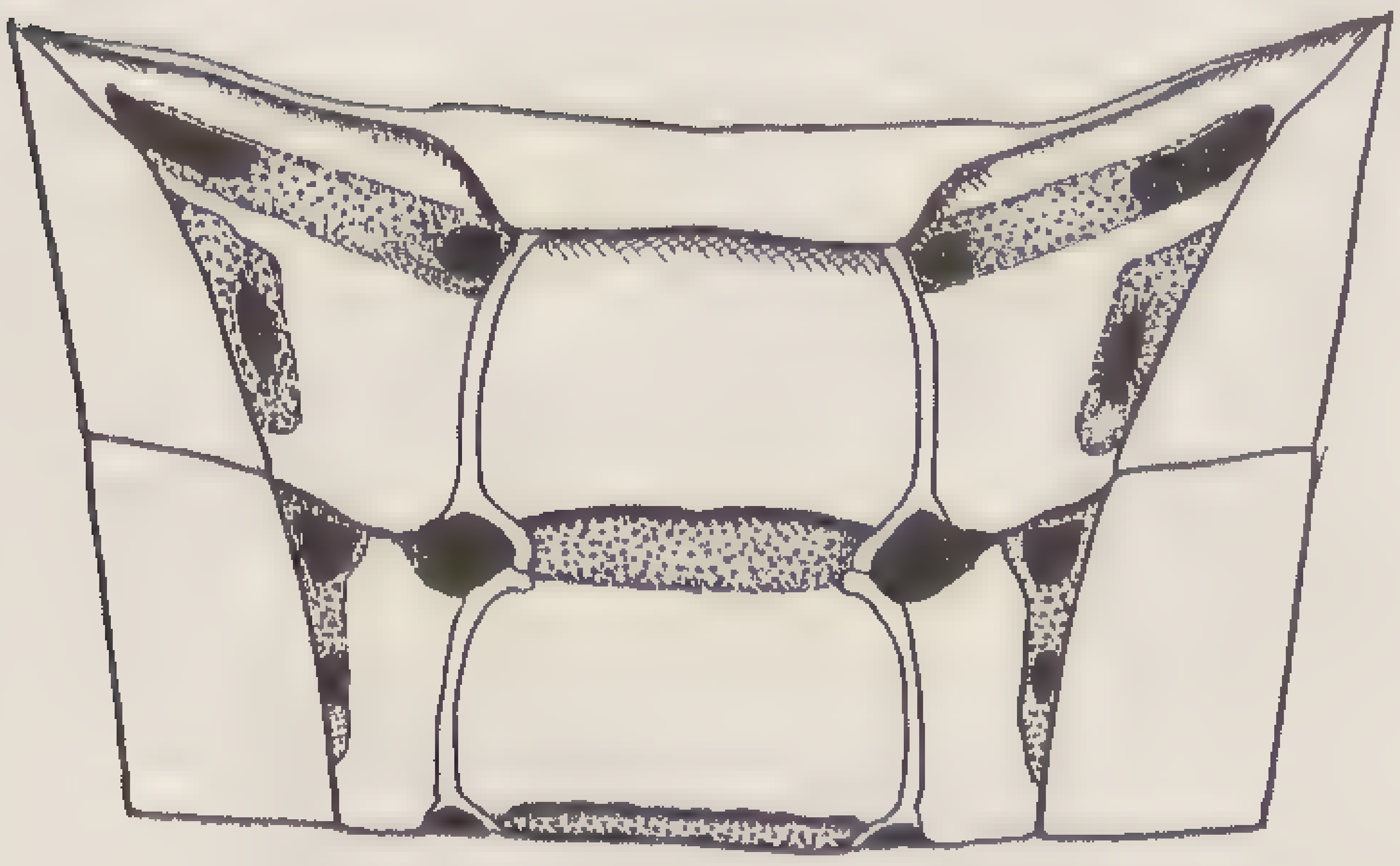
FIG. 28a. Basal segments of *Rhagovelia* (*Rhagovelia*) *crassipes* Champion; 28b, apical segments of winged female; 28c, apical portion of pronotum.

FIG. 29a. Basal segments of *Rhagovelia* (*Rhagovelia*) *perfidiosa* Bacon; 29b, apical segments of winged female.

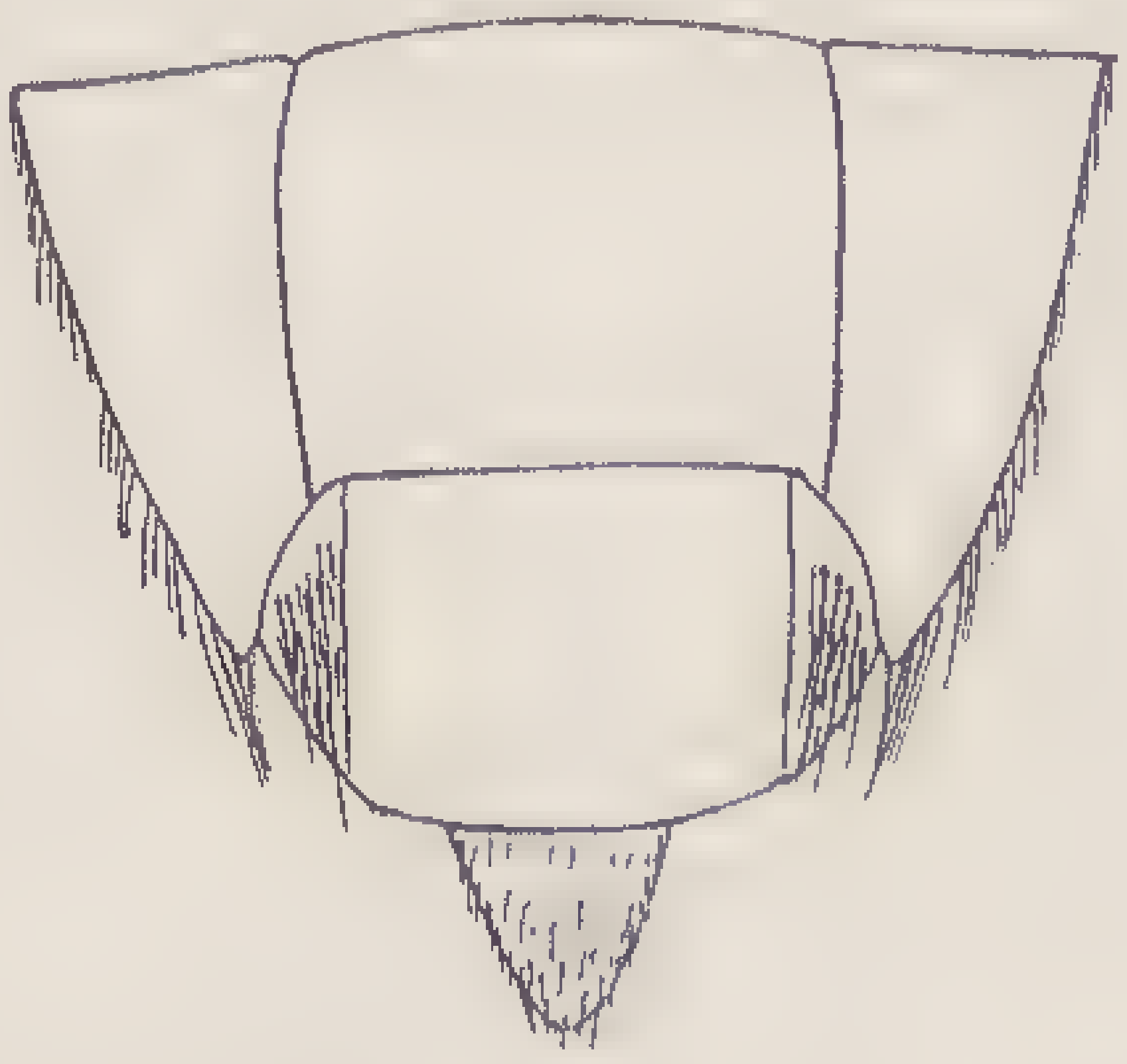
FIG. 30a. Apical segments of winged form of *Rhagovelia* (*Rhagovelia*) *sinuata* Gould; 30b, basal segments.

FIG. 31a. Basal segments of *Rhagovelia* (*Rhagovelia*) *palea* Bacon; 31b, apical segments of winged female.

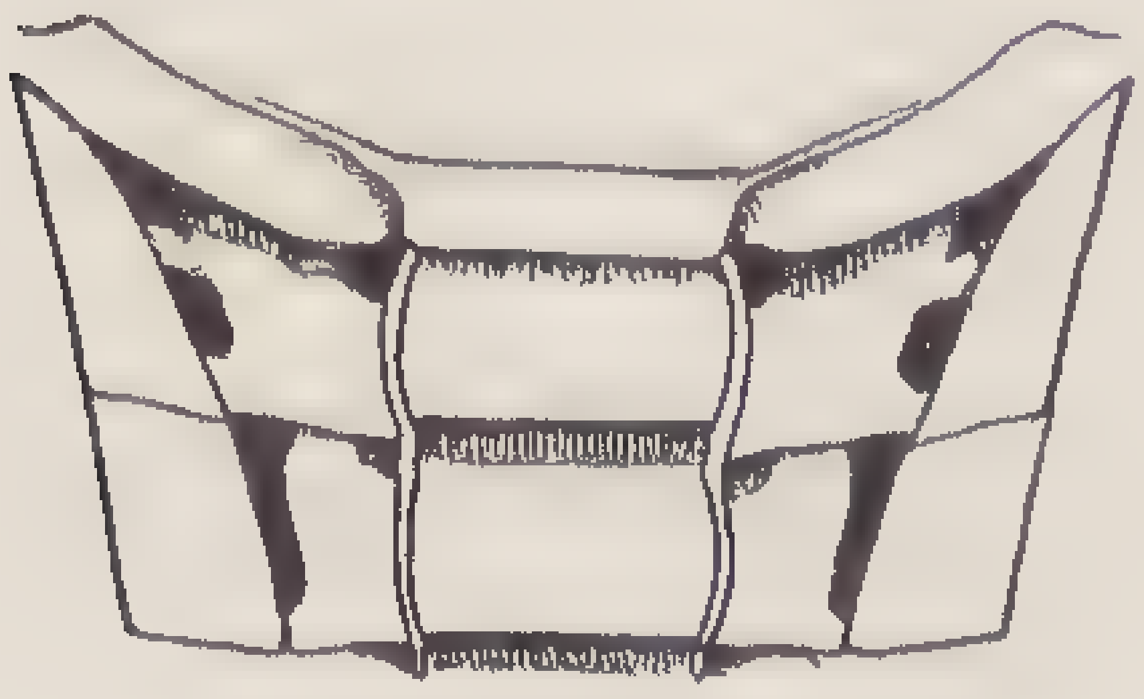
PLATE 9



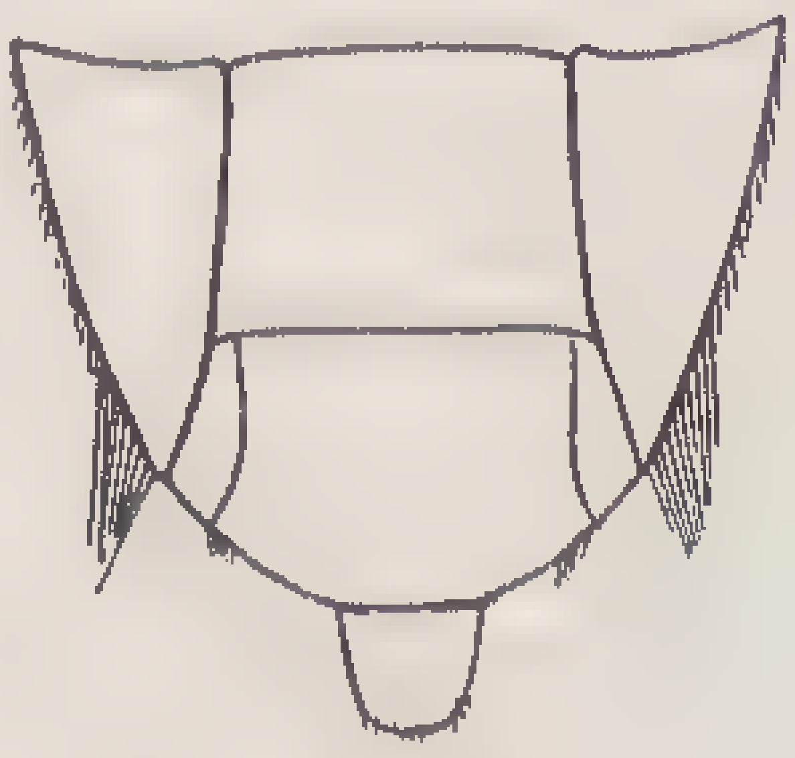
28a R.(R.) crassipes



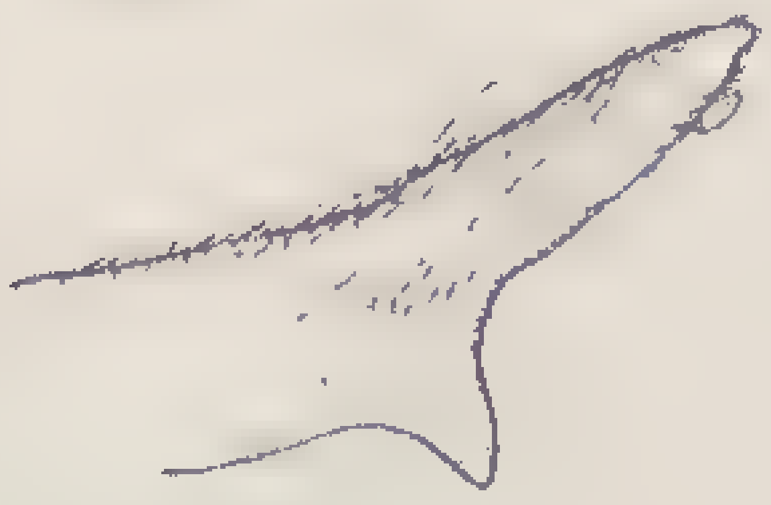
28b



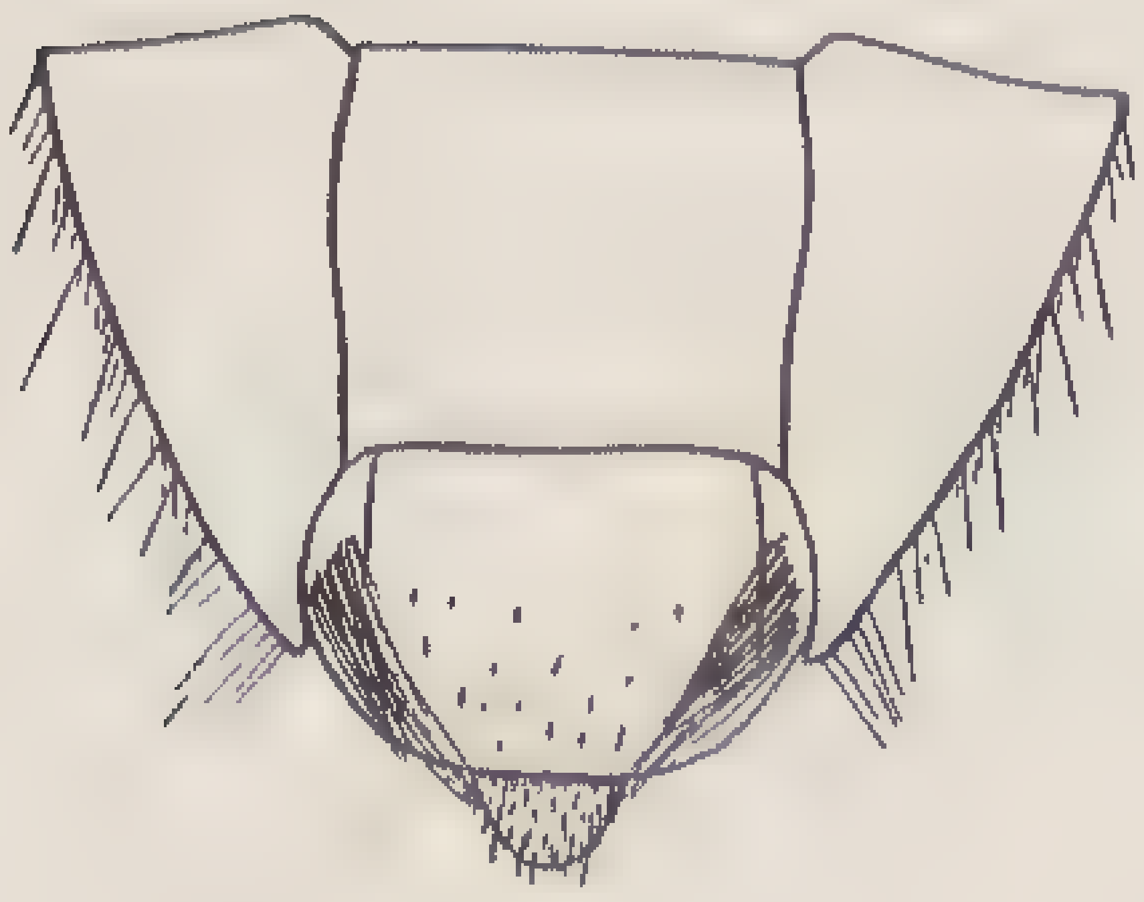
29a R.(R.) perfidiosa



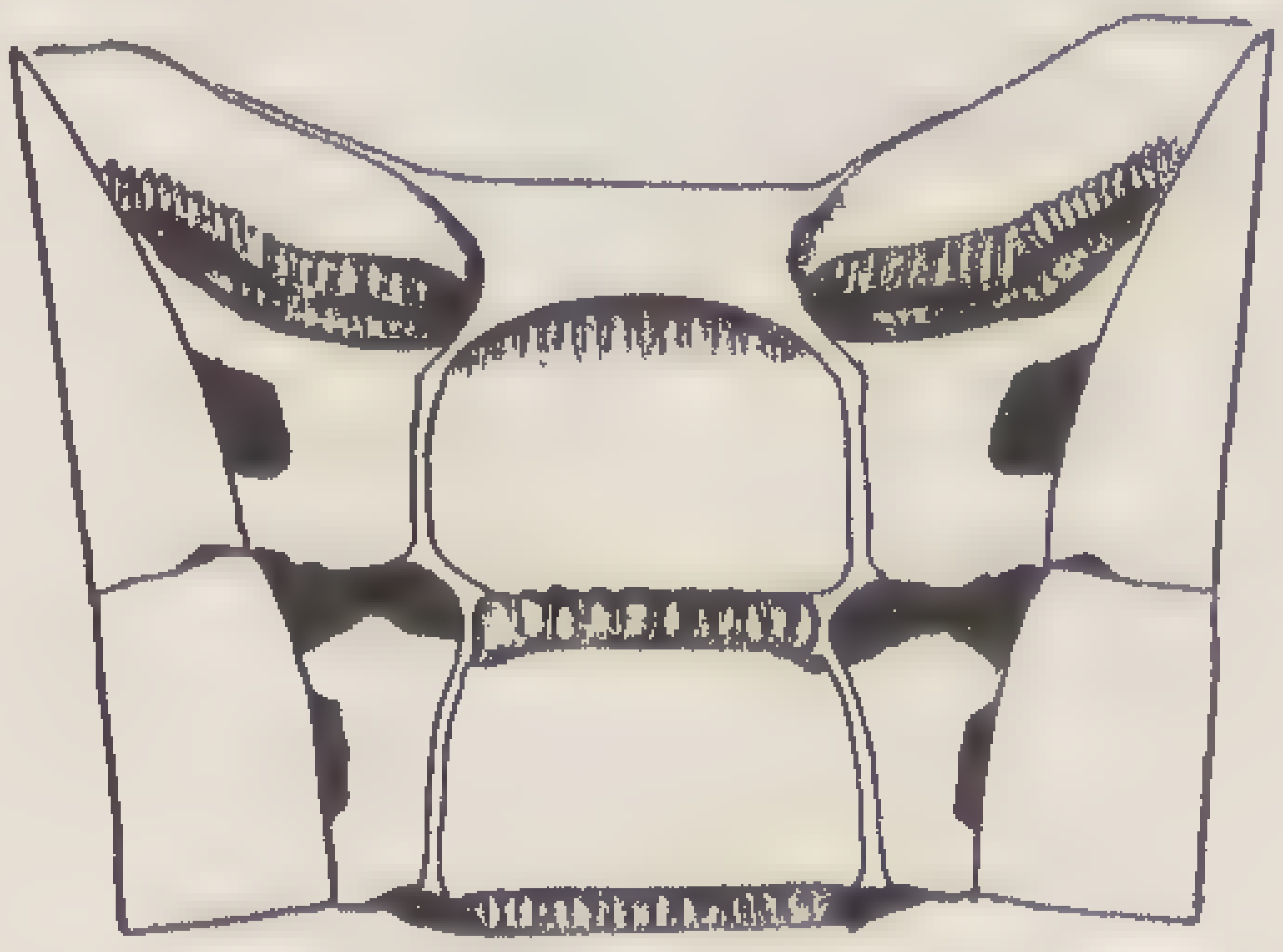
29b



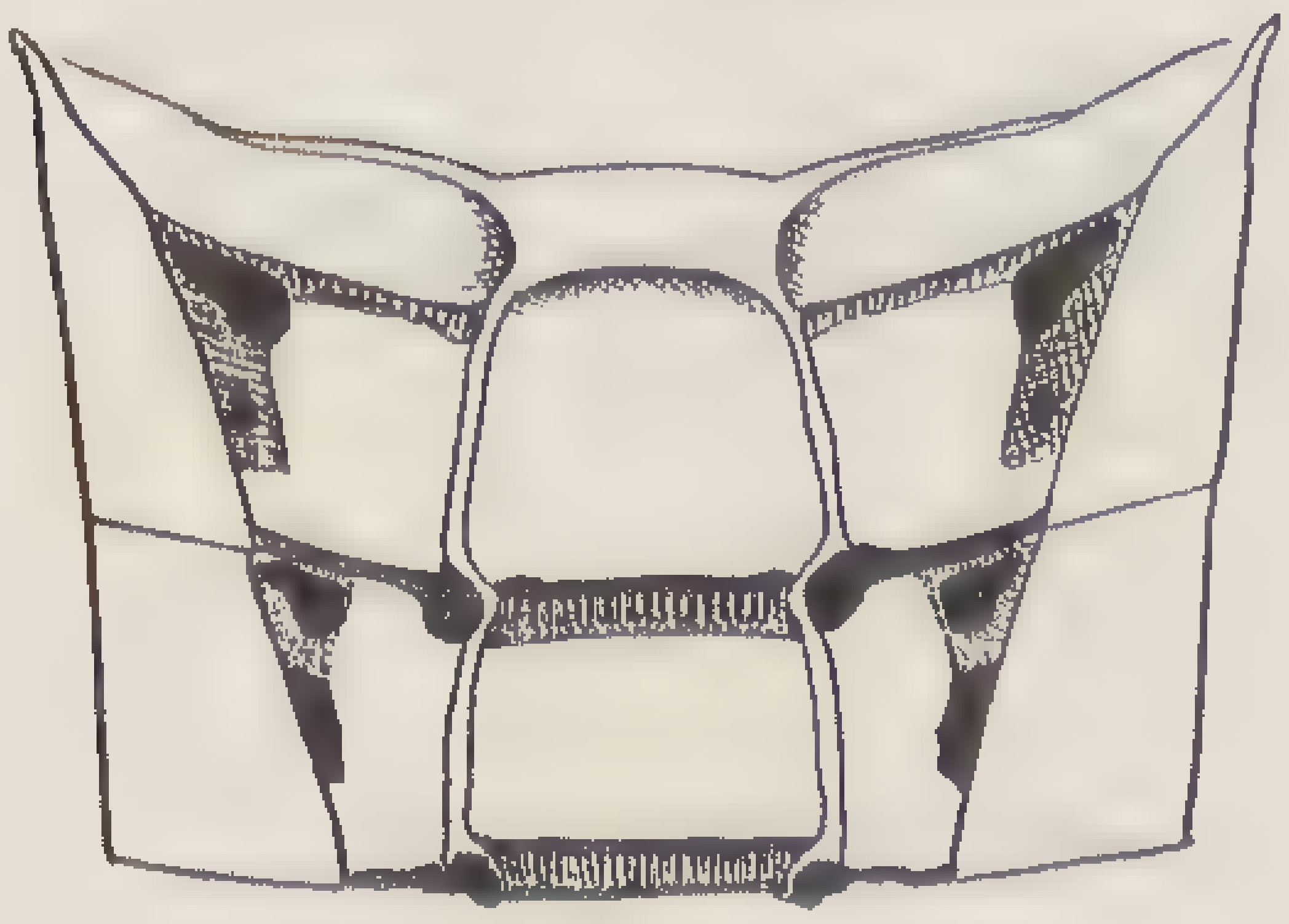
28c



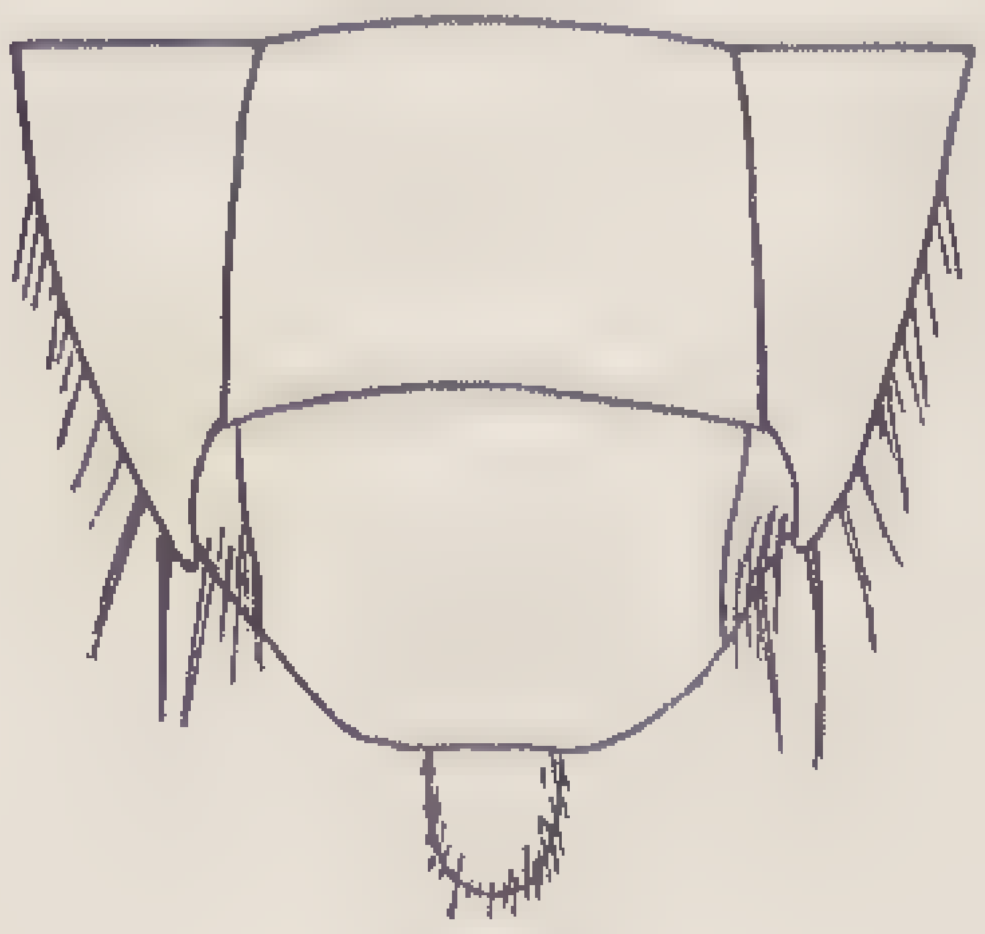
30a R. (R.) sinuata



30b



31a R.(R.) palea



31b

PLATE 10

DORSAL VIEW OF ABDOMINAL SEGMENTS AND LATERAL VIEW OF PRONOTUM

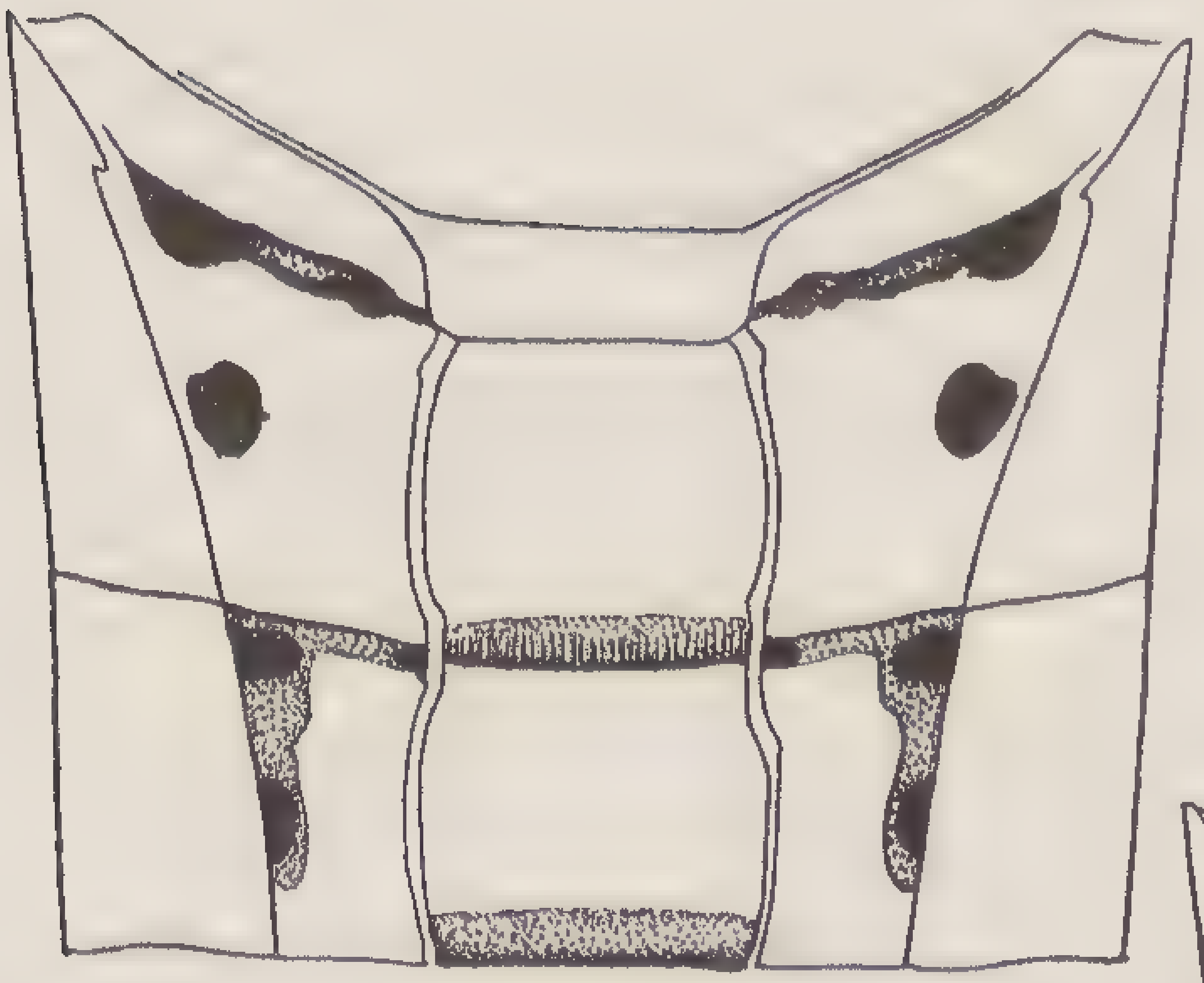
FIG. 32a. Basal segments of *Rhagovelia* (*Rhagovelia*) *varipes* Champion; 32b, apical segments of winged female.

FIG. 33a. Basal segments of *Rhagovelia* (*Rhagovelia*) *horrida* Bacon; 33b, apical segments of winged female.

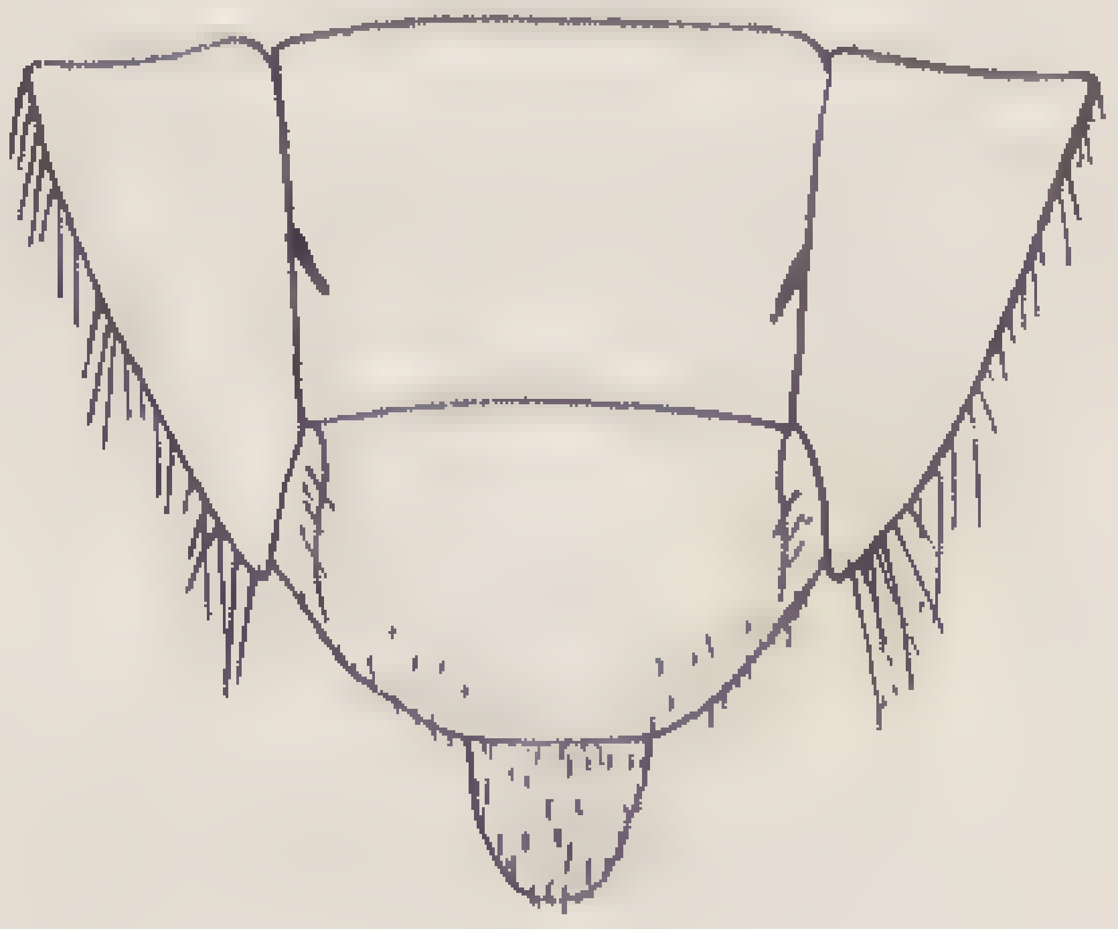
FIG. 34. Apical portion of pronotum *Rhagovelia* (*Rhagovelia*) *oriander* Parshley.

FIG. 35a. Basal segments of *Rhagovelia* (*Rhagovelia*) *nitida* Bacon; 35b, apical segments of winged female.

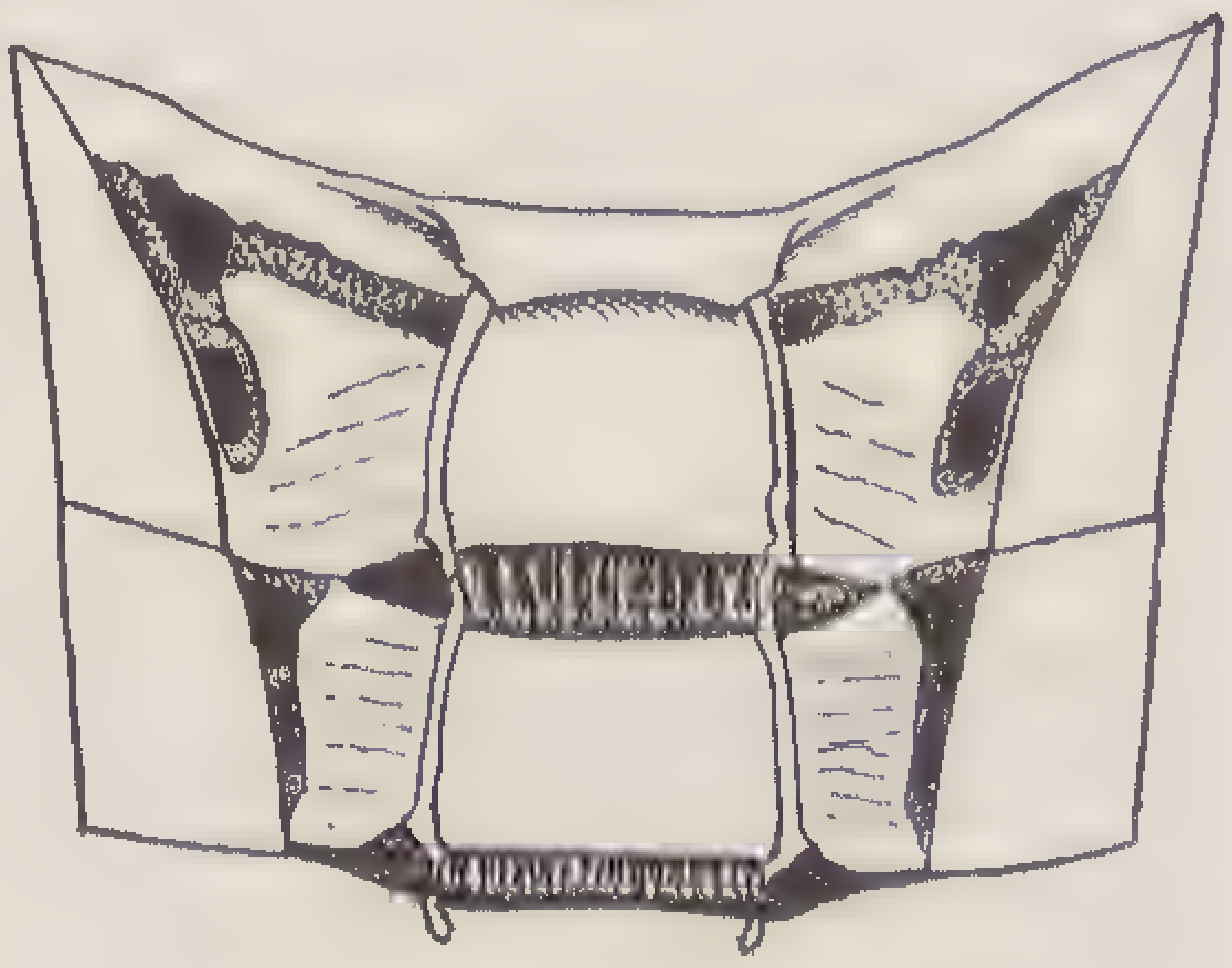
PLATE 10



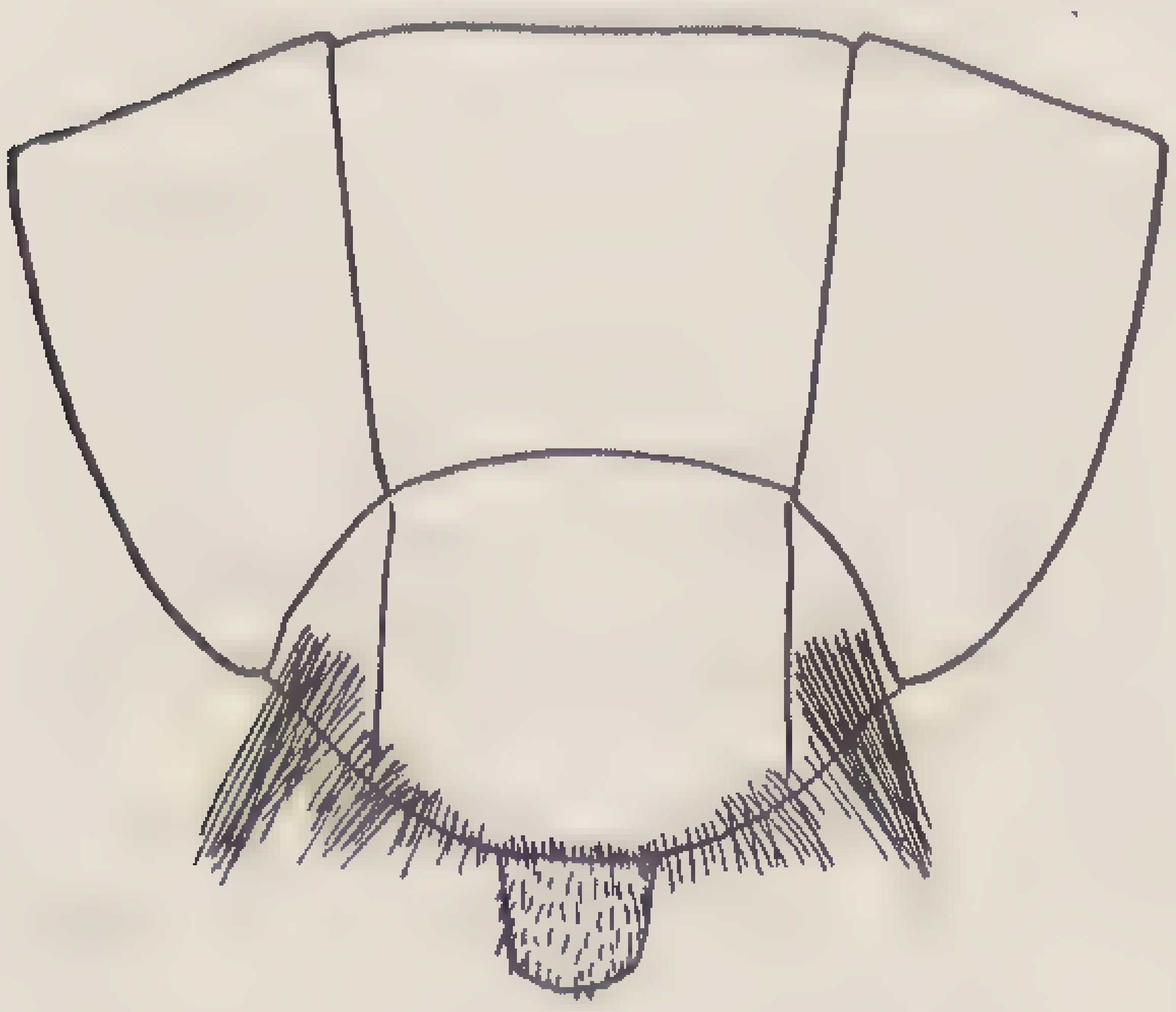
32a R.(R.) varipes



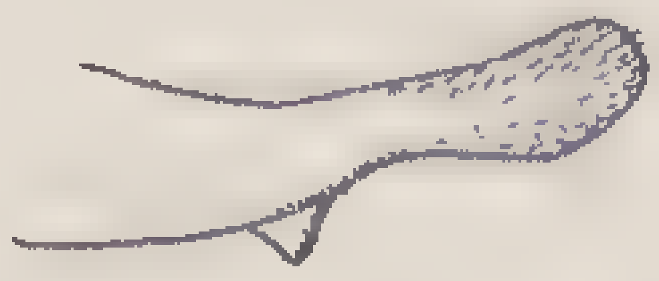
33b



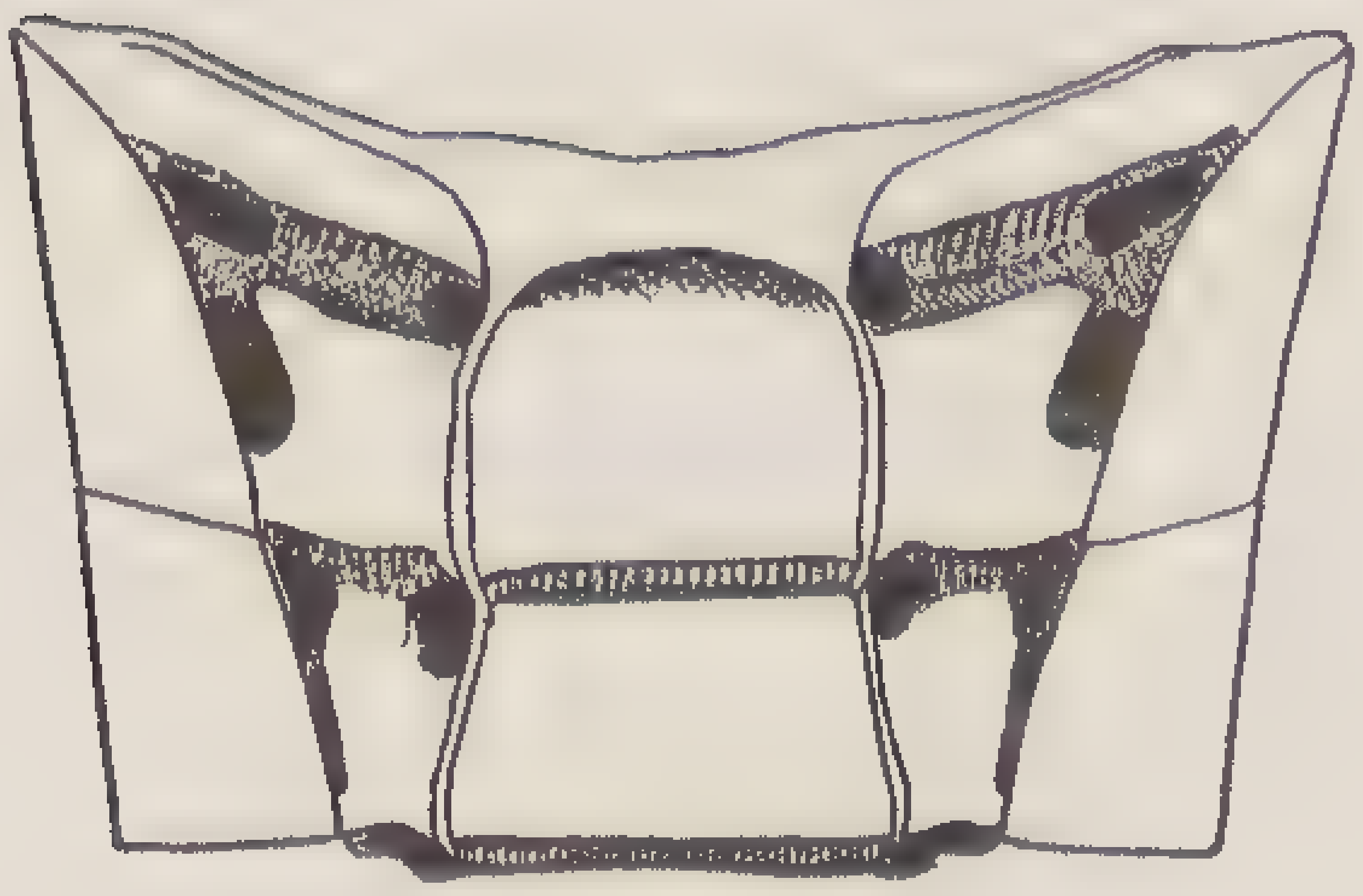
33a R.(R.) horrida



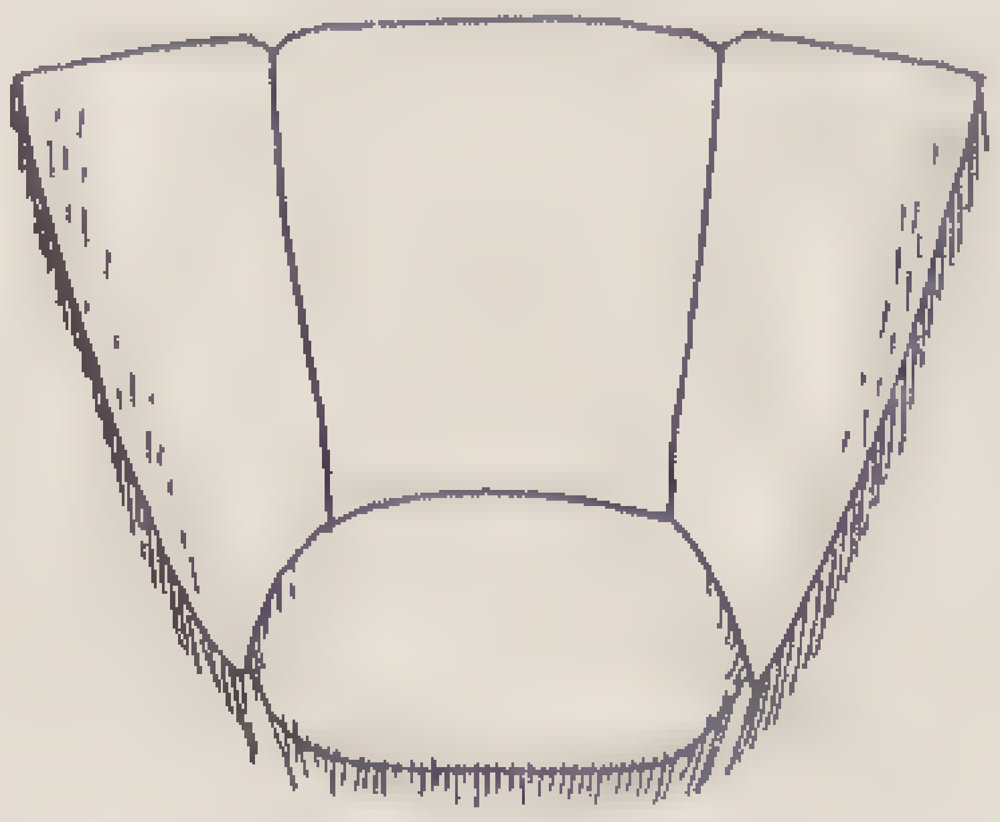
32b



34 R.(R.) oriander



35a R.(R.) nitida



35b

PLATE 11

DORSAL VIEW OF ABDOMINAL SEGMENTS AND LATERAL VIEW OF PRONOTUM

FIG. 36a. Basal abdominal segments of *Rhagovelia* (*Rhagovelia*) *tayloriella* Kirkaldy; 36b, apical portion of pronotum; 36c, apical abdominal segments of winged female.

FIG. 37a. Basal abdominal segments of *Rhagovelia* (*Rhagovelia*) *collaris* (Burmeister); 37b, apical portion of pronotum; 37c, apical abdominal segments of winged female.

FIG. 38a. Basal abdominal segments of *Rhagovelia* (*Rhagovelia*) *impensa* Bacon; 38b, apical portion of pronotum; 38c, apical abdominal segments of winged female.

PLATE 11

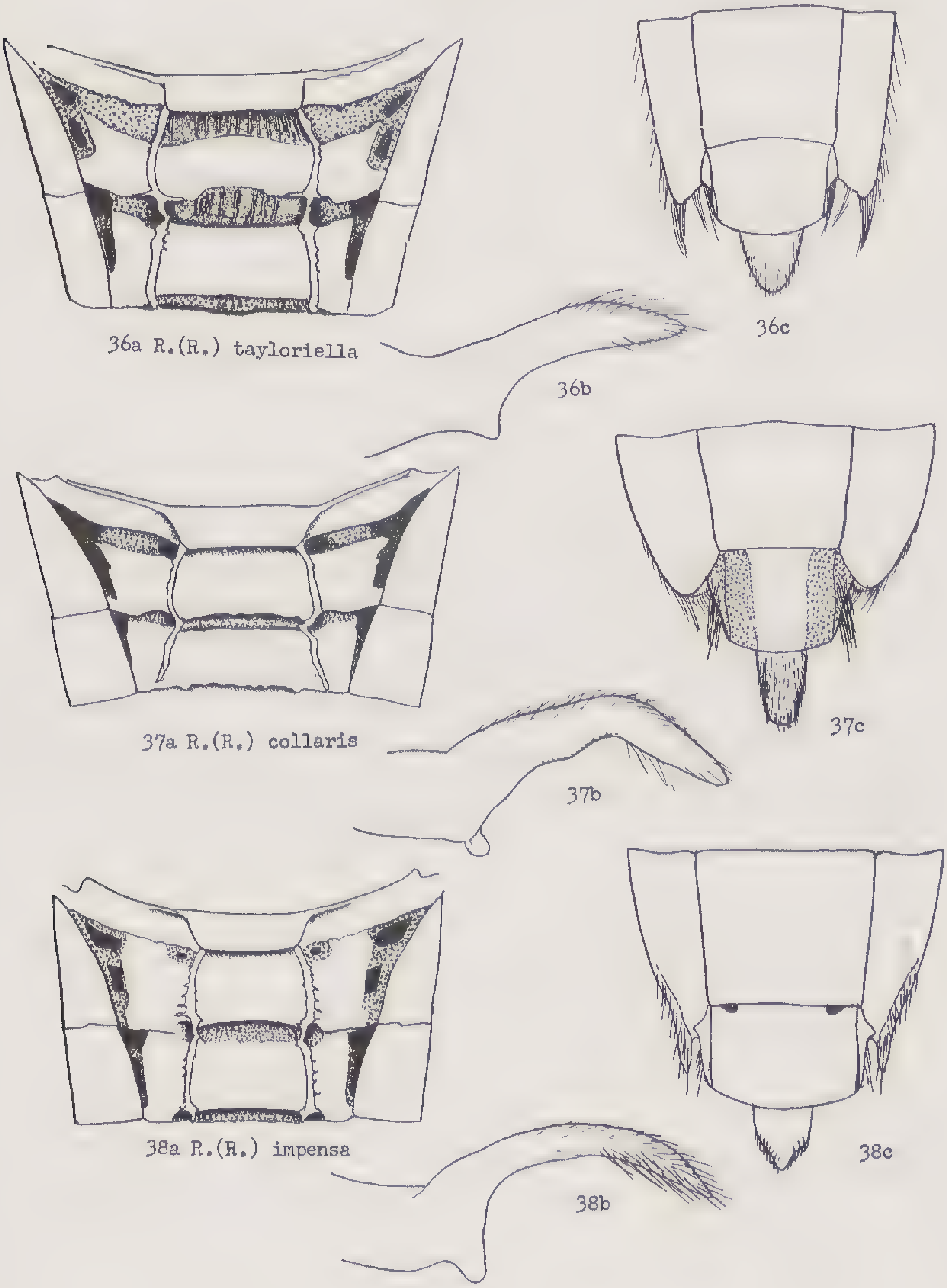

36a R.(R.) tayloriella
37a R.(R.) collaris
38a R.(R.) impensa

PLATE 12

DORSAL VIEW OF ABDOMINAL SEGMENTS AND LATERAL VIEW OF PRONOTUM

FIG. 39a. Basal abdominal segments of *Rhagovelia* (*Rhagovelia*) *armata* (Burmeister); 39b, apical portion of pronotum; 39c, apical abdominal segments of winged female.

FIG. 40a. Basal abdominal segments of *Rhagovelia* (*Rhagovelia*) *acuminata* Bacon; 40b, apical portion of pronotum; 41c, apical abdominal segments of winged female.

FIG. 41a. Basal abdominal segments of *Rhagovelia* (*Rhagovelia*) *planipes* Gould; 41b, apical portion of pronotum; 41c, apical abdominal segments of winged female.

PLATE 12

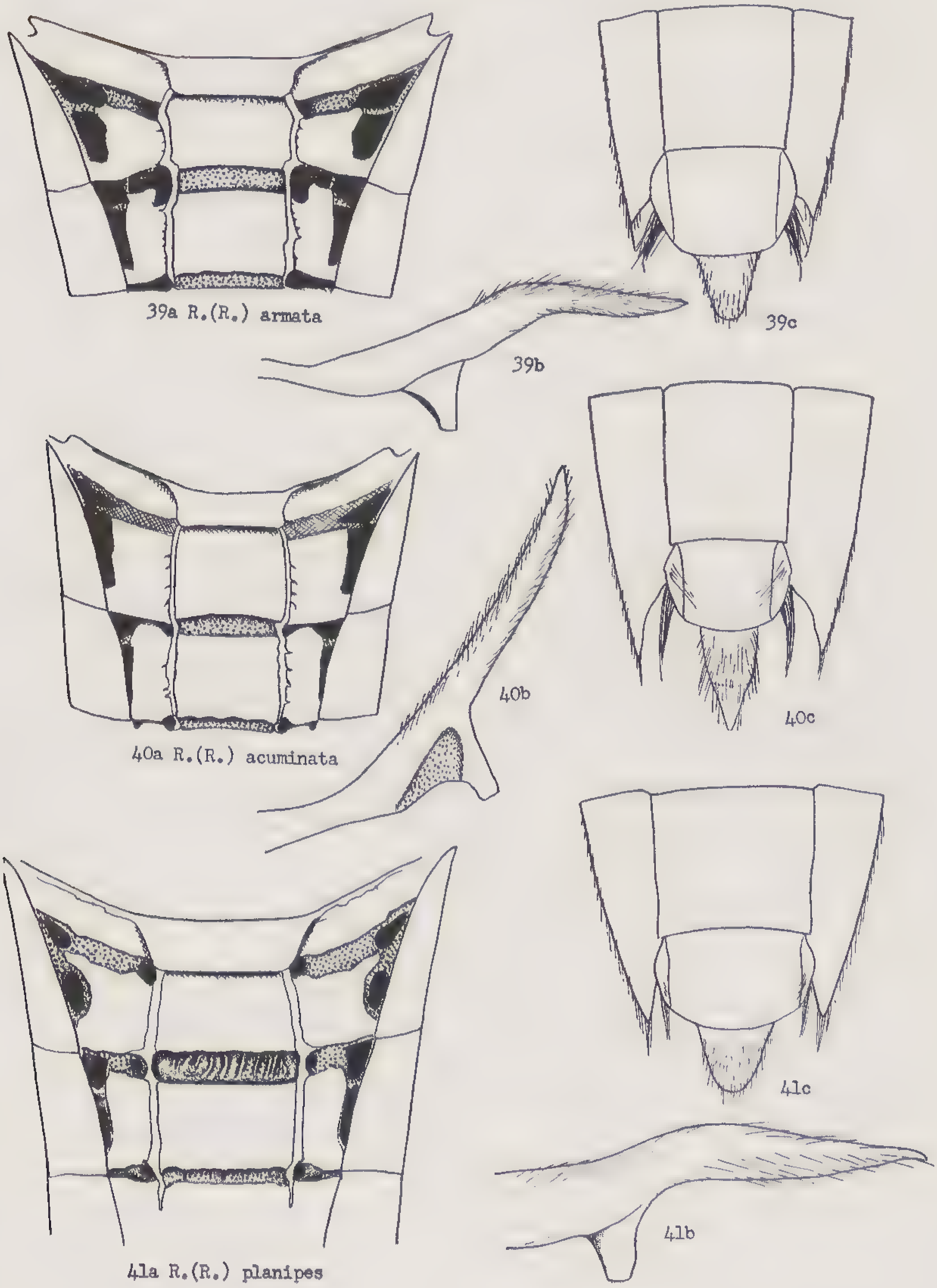

39a R.(R.) armata
40a R.(R.) acuminata
41a R.(R.) planipes

PLATE 13

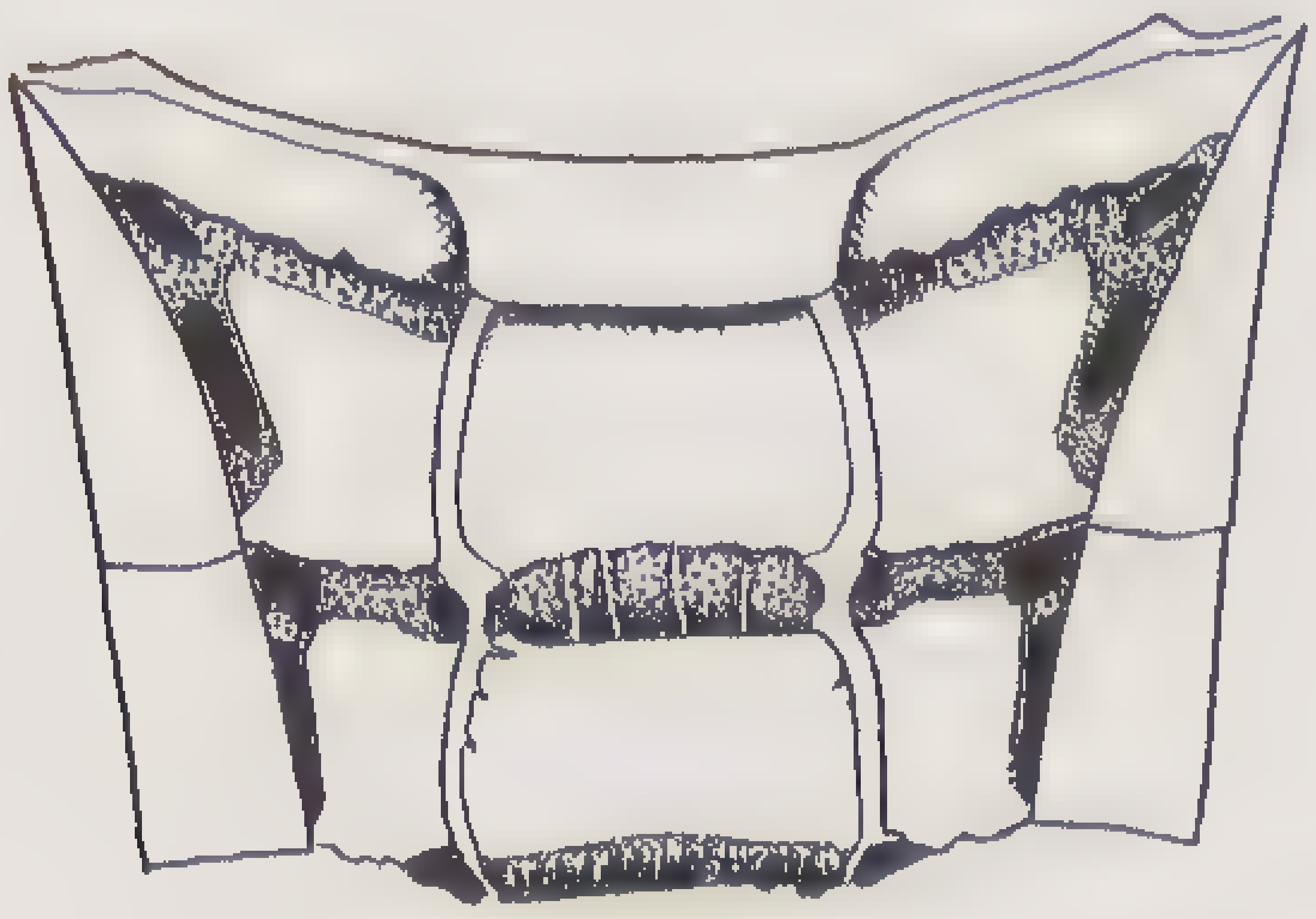
DORSAL VIEW OF ABDOMINAL SEGMENTS AND LATERAL VIEW OF PRONOTUM

FIG. 42a. Basal abdominal segments of *Rhagovelia* (*Rhagovelia*) *distincta* Champion; 42b, apical portion of pronotum; 42c, apical abdominal segments of winged female.

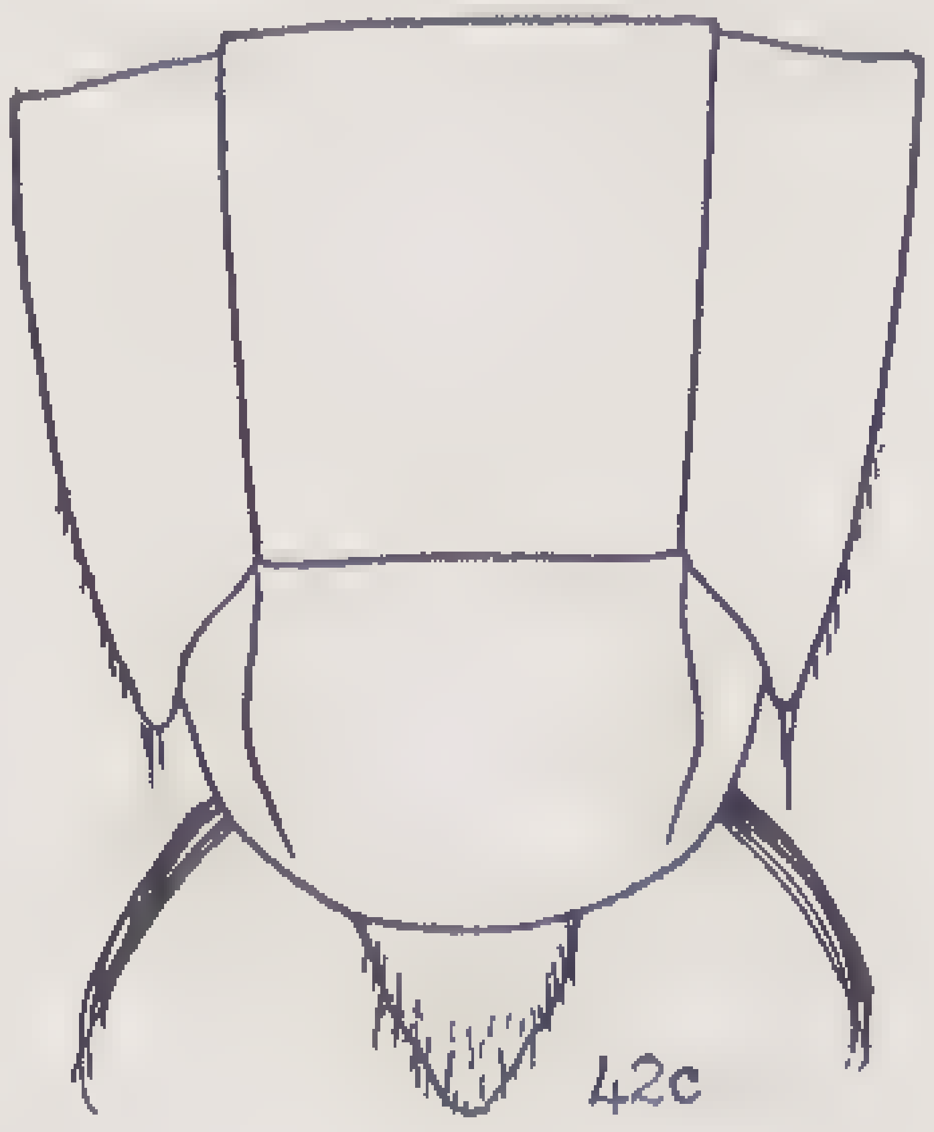
FIG. 43a. Basal abdominal segments of *Rhagovelia* (*Rhagovelia*) *rivale* Bueno; 43b, apical portion of pronotum; 43c, apical abdominal segments of winged female.

FIG. 44a. Basal abdominal segments of *Rhagovelia* (*Rhagovelia*) *obesa* Uhler; 44b, apical portion of pronotum; 44c, apical abdominal segments of winged female.

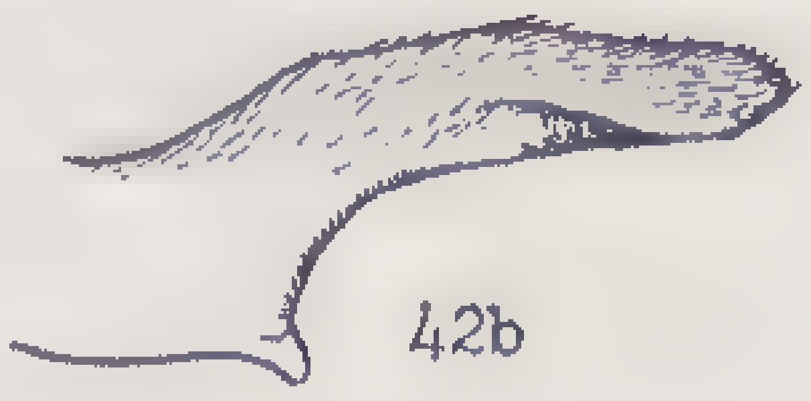
PLATE 13



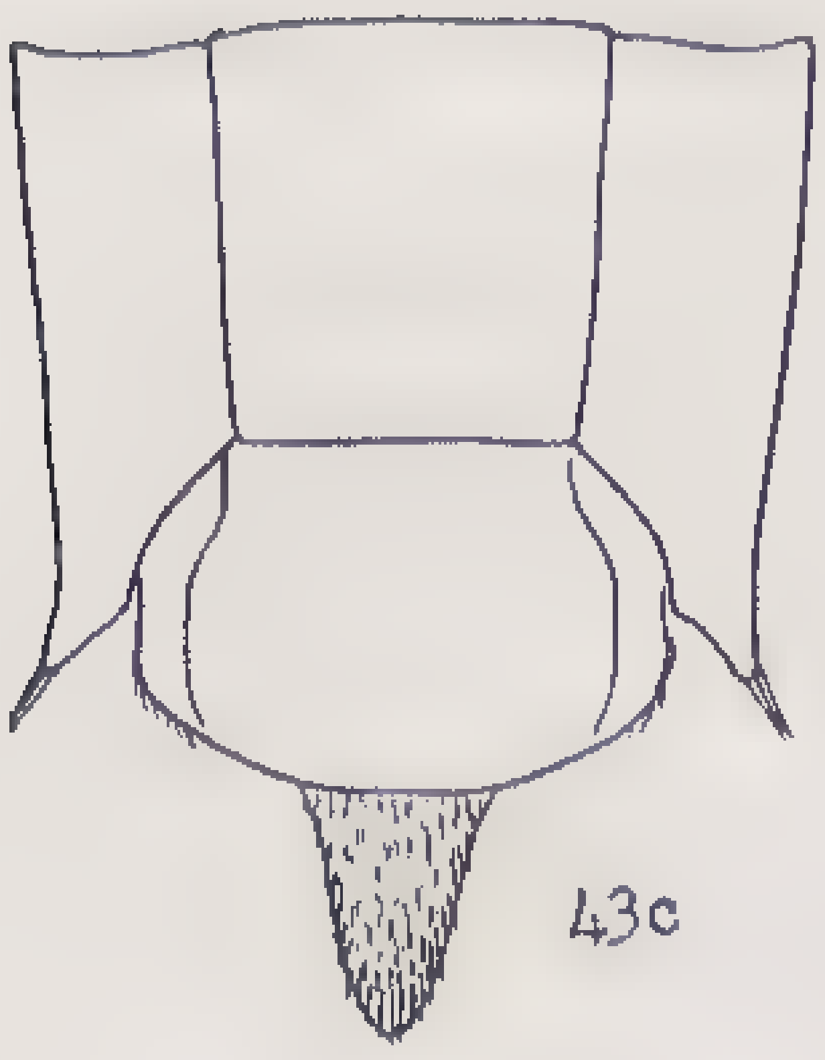
42a R.(R.) distincta



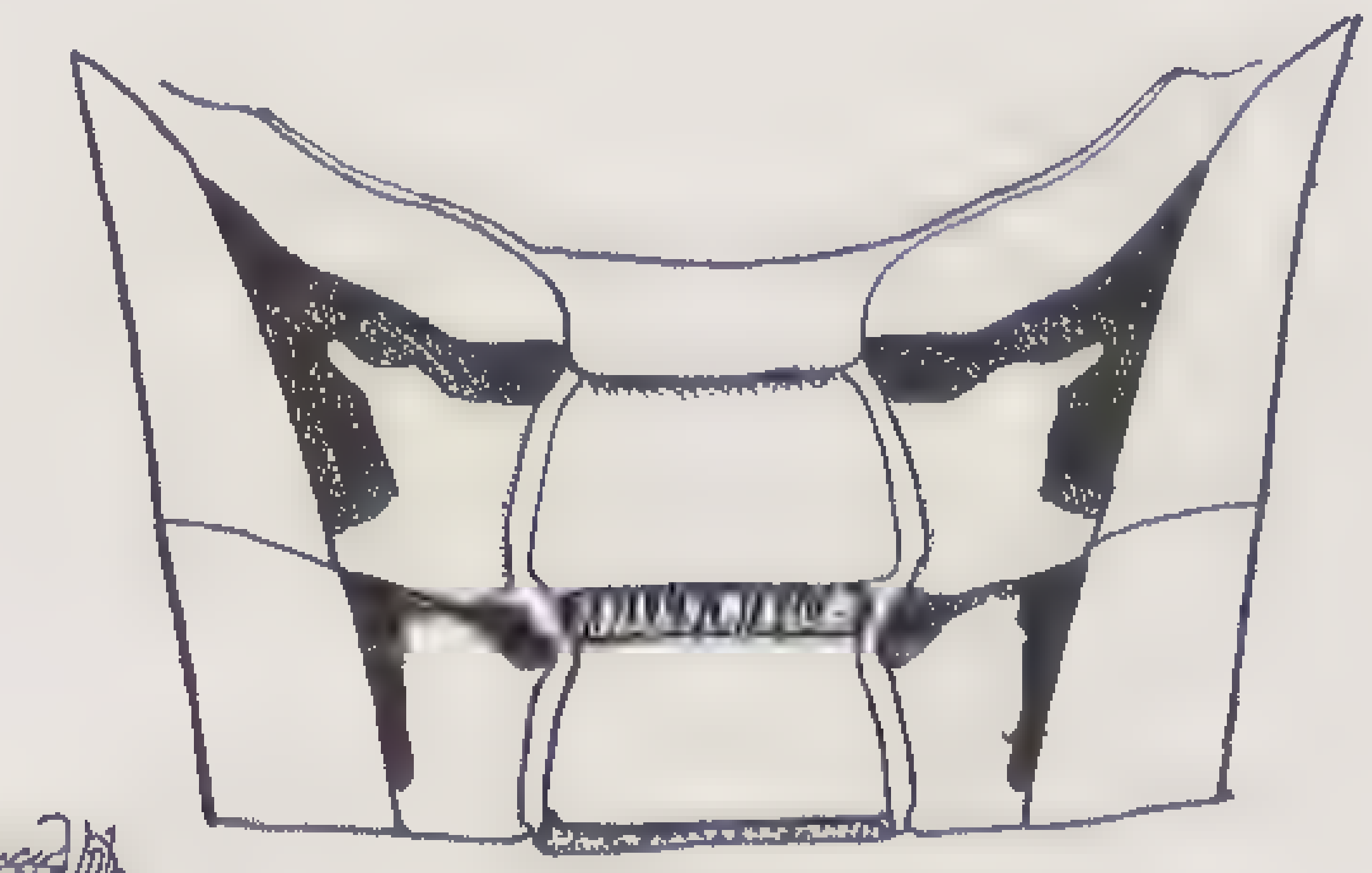
42c



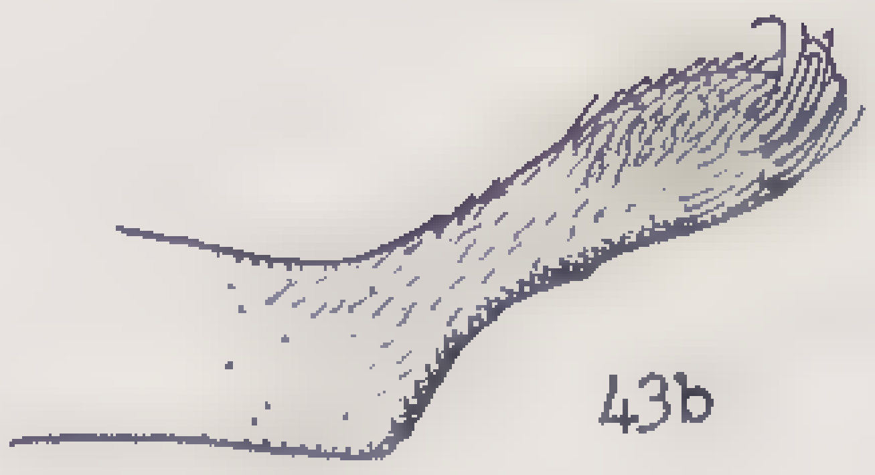
42b



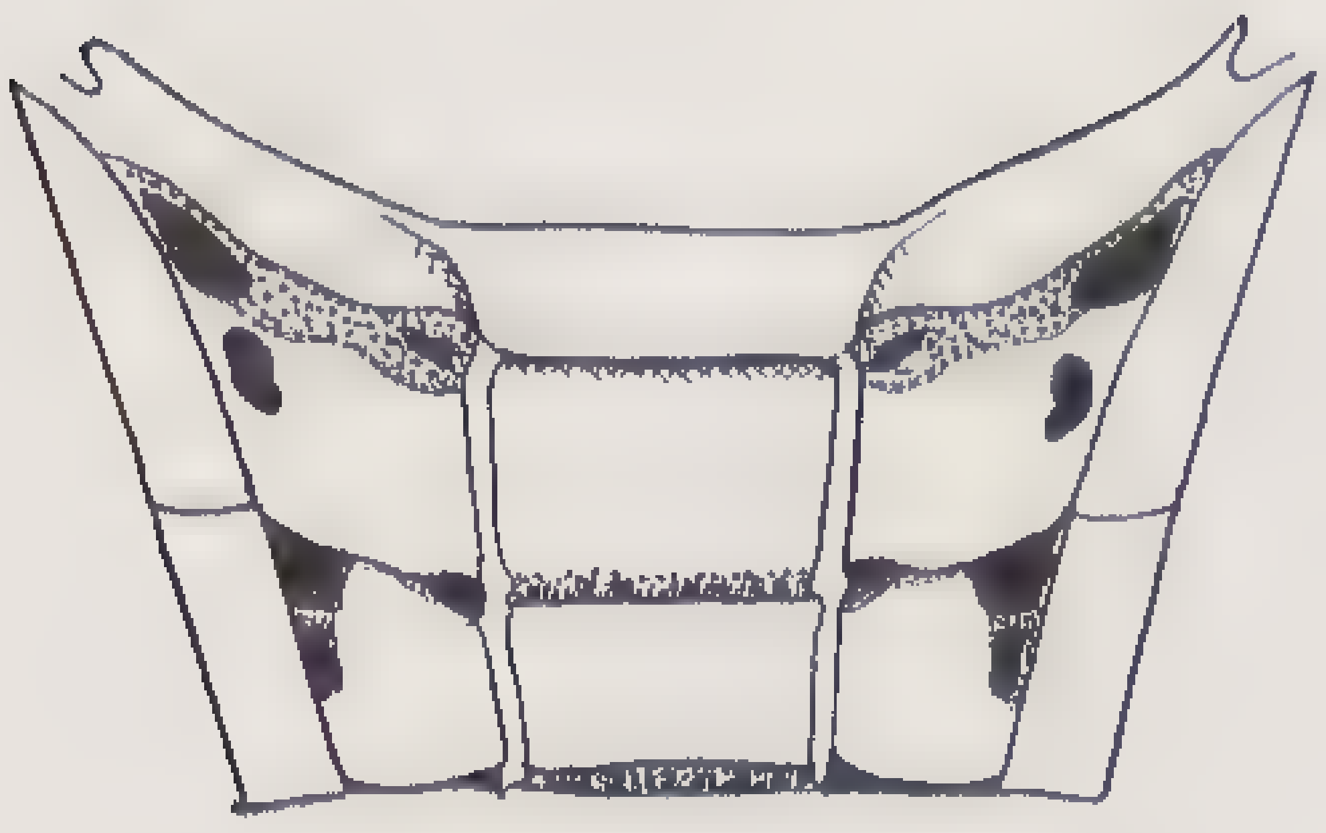
43c



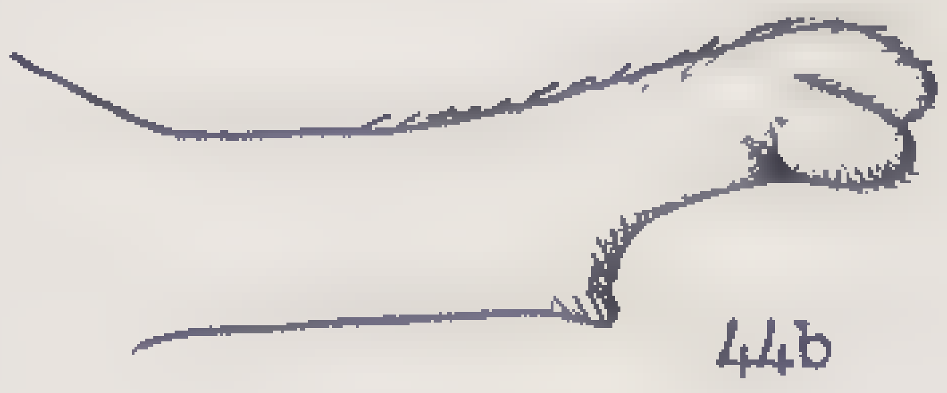
43a R.(R.) rivale



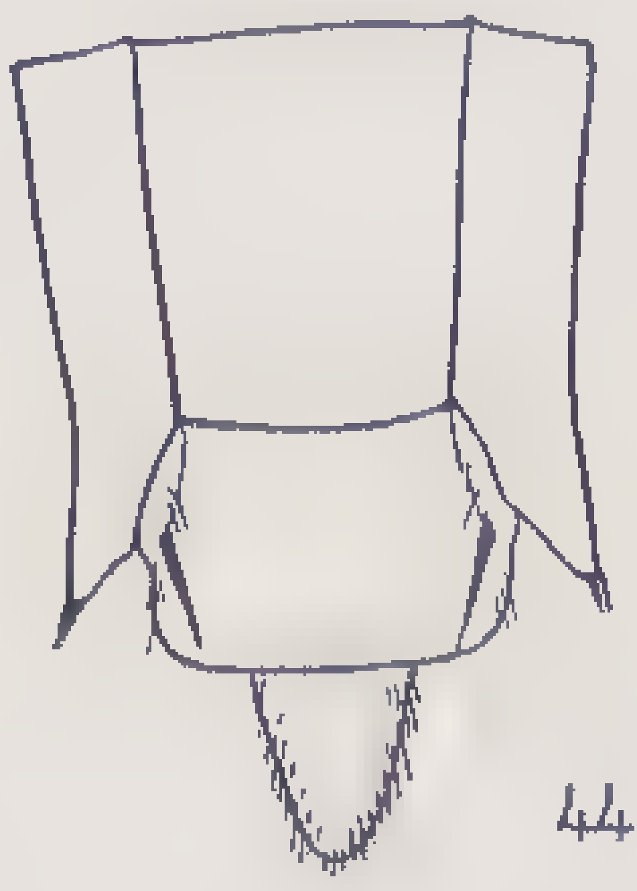
43b



44a R.(R.) obesa



44b



44c

PLATE 14

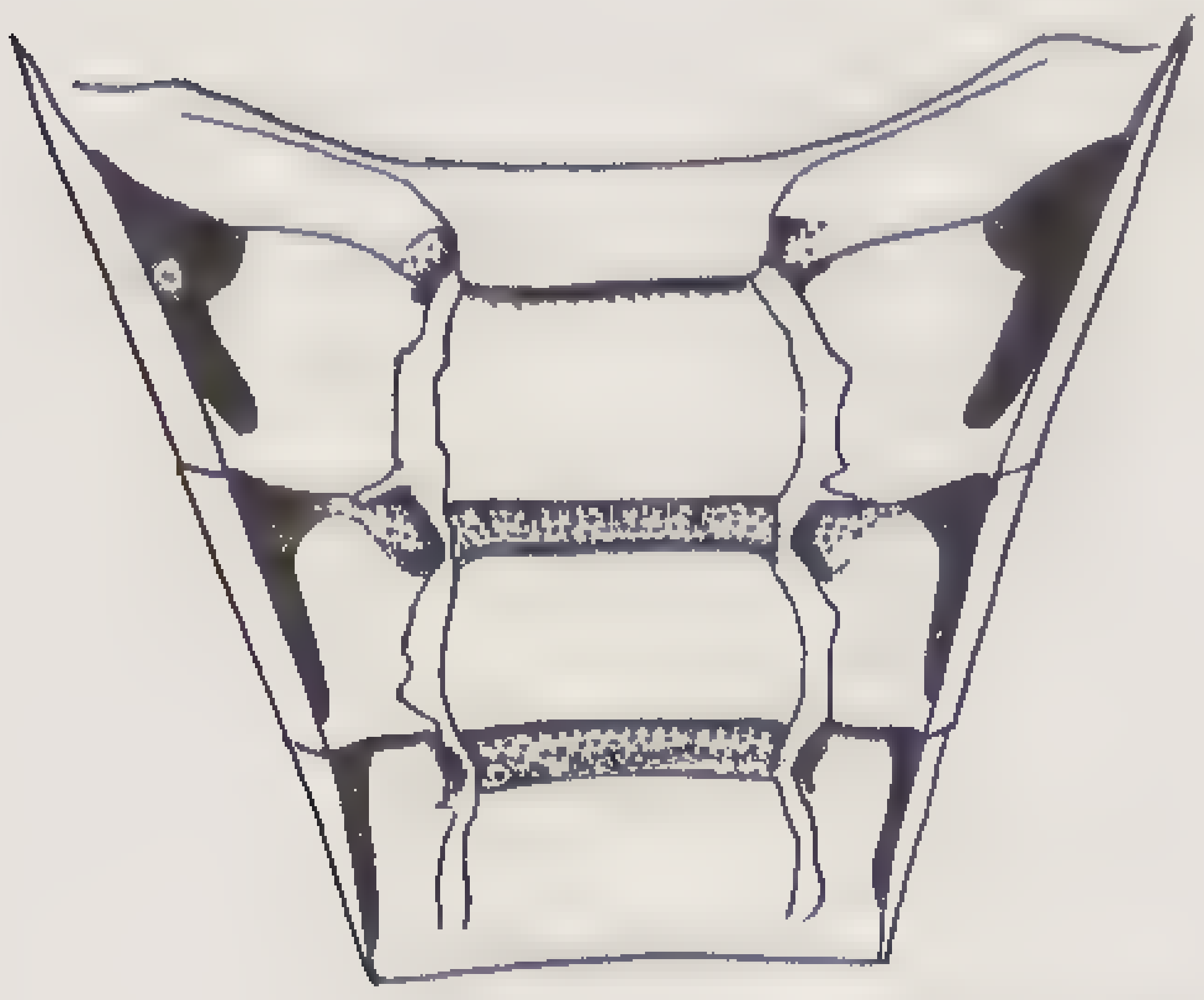
DORSAL VIEW OF ABDOMINAL SEGMENTS AND LATERAL VIEW OF PRONOTUM

FIG. 45a. Basal abdominal segments of *Rhagovelia* (*Rhagovelia*) *ainslei* Drake and Harris; 45b, apical portion of pronotum; 45c, apical abdominal segments of winged female.

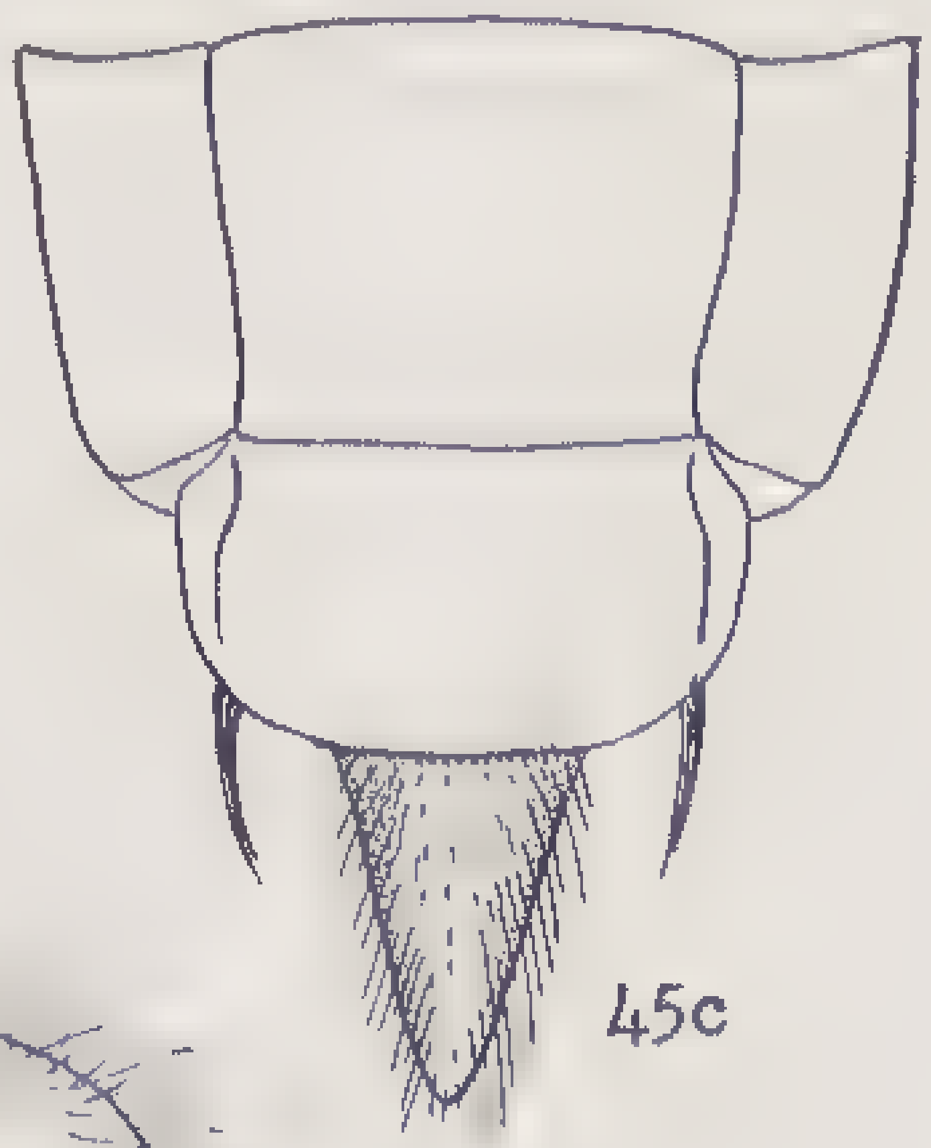
FIG. 46a. Basal abdominal segments of *Rhagovelia* (*Rhagovelia*) *gracilis* Bacon; 46b, apical portion of pronotum; 46c, apical abdominal segments of winged female.

FIG. 47a. Basal abdominal segments of *Rhagovelia* (*Rhagovelia*) *becki* Drake and Harris; 47b, apical portion of pronotum; 47c, apical abdominal segments.

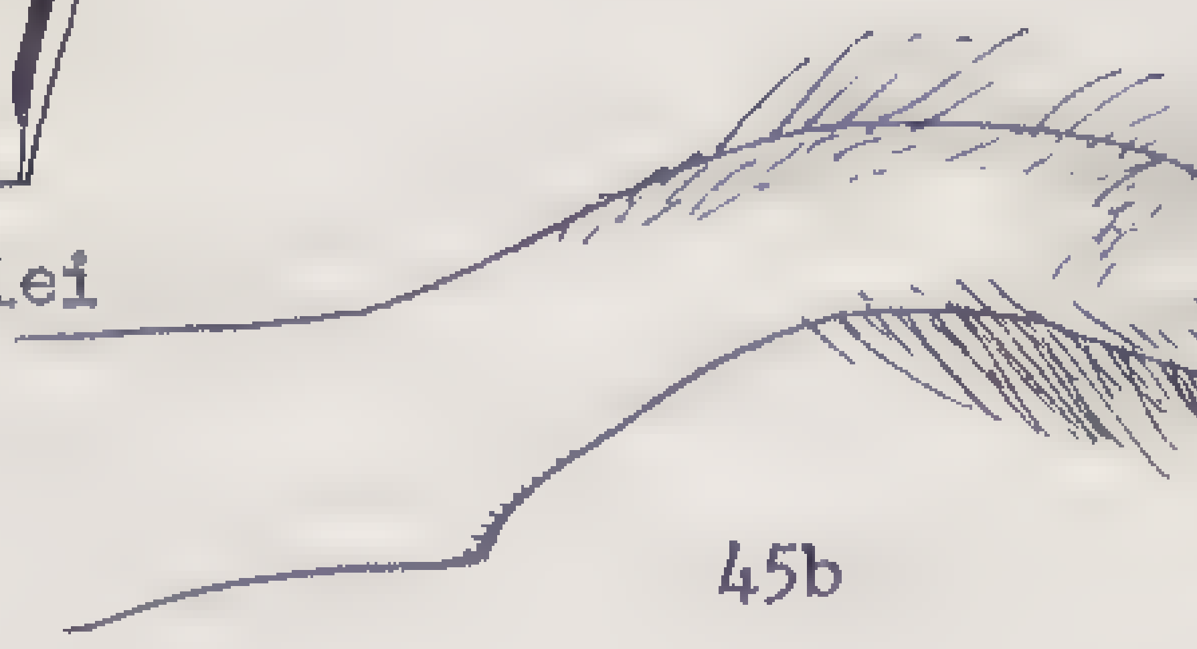
PLATE 14



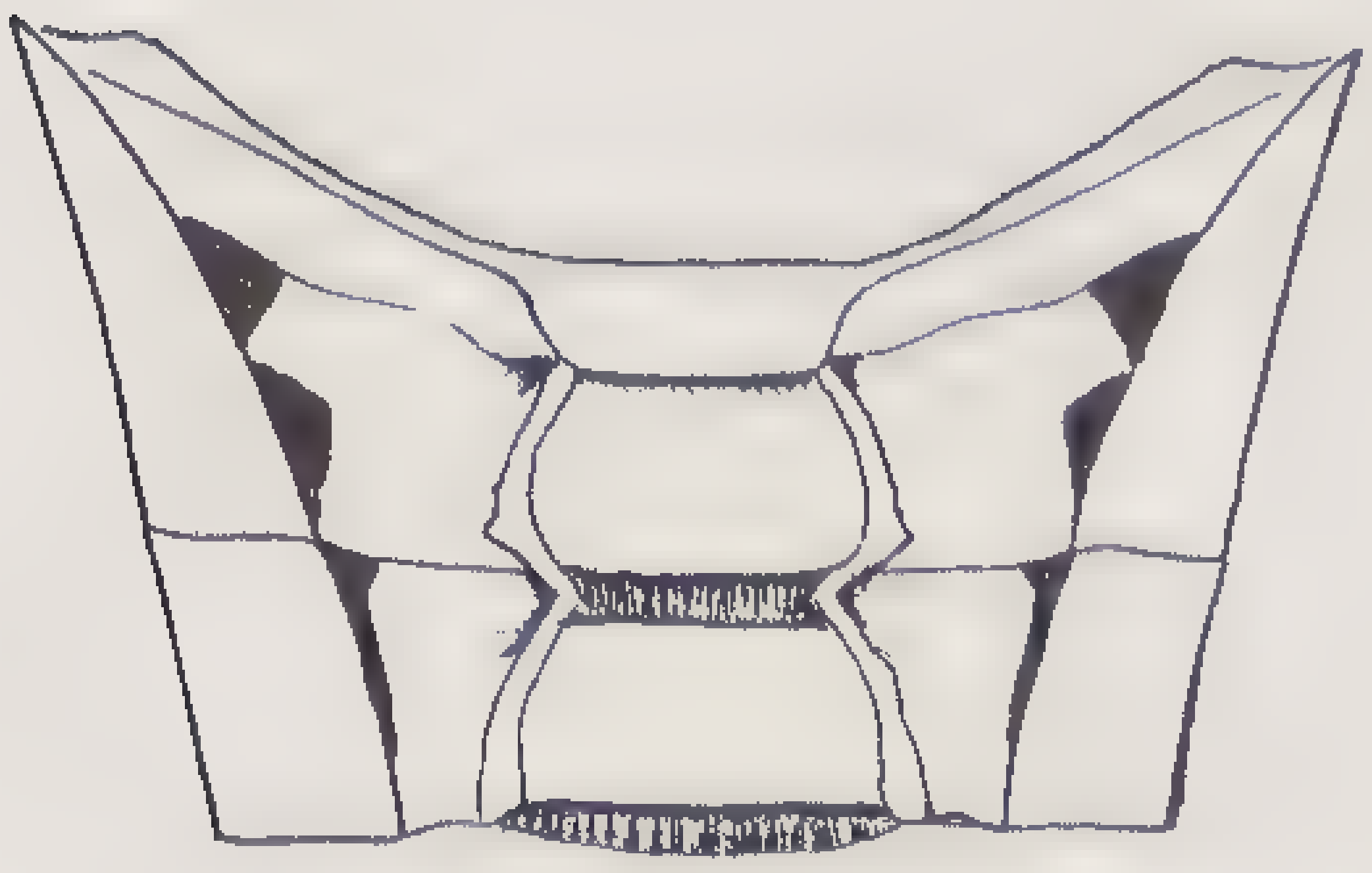
45a R.(R.) ainslei



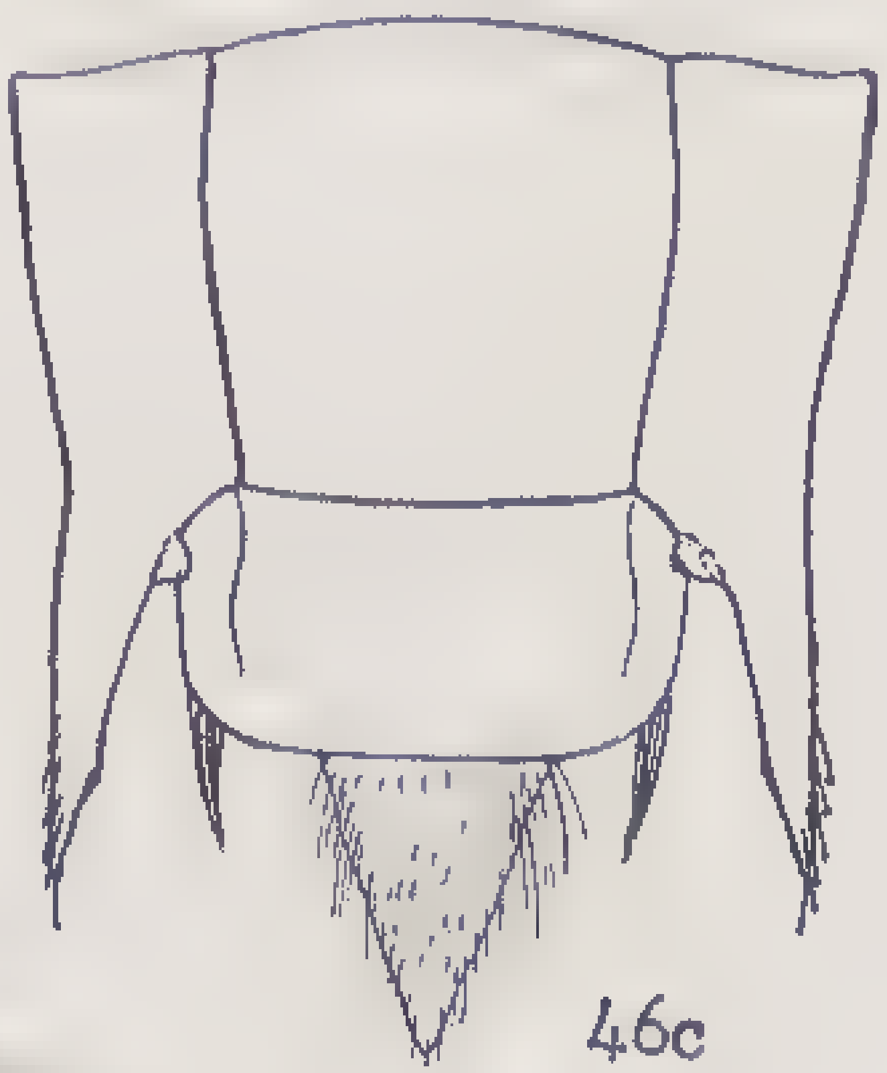
45c



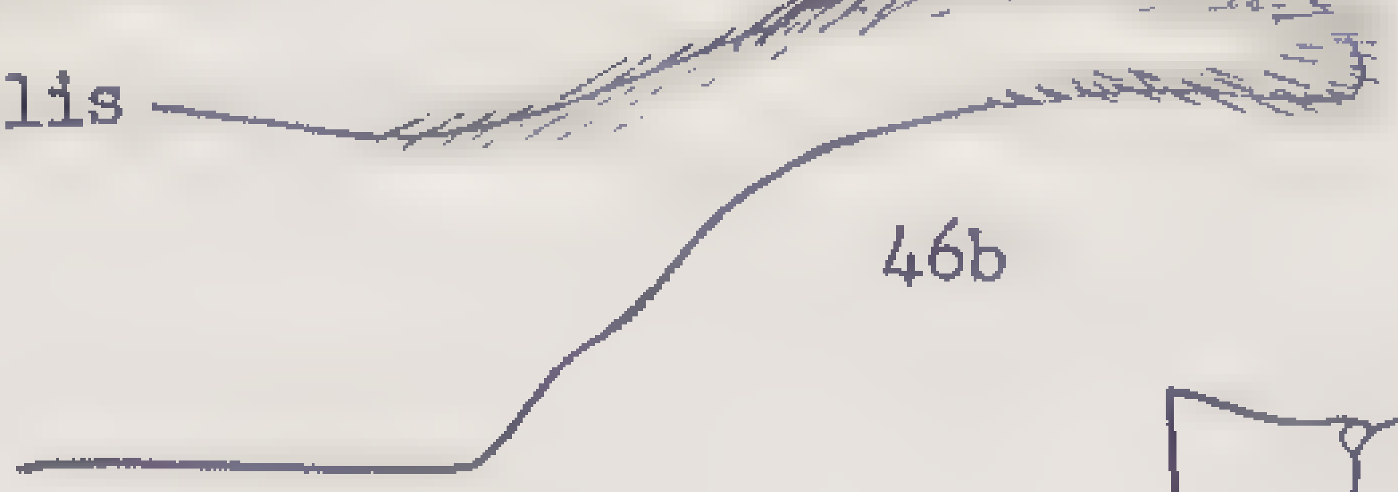
45b



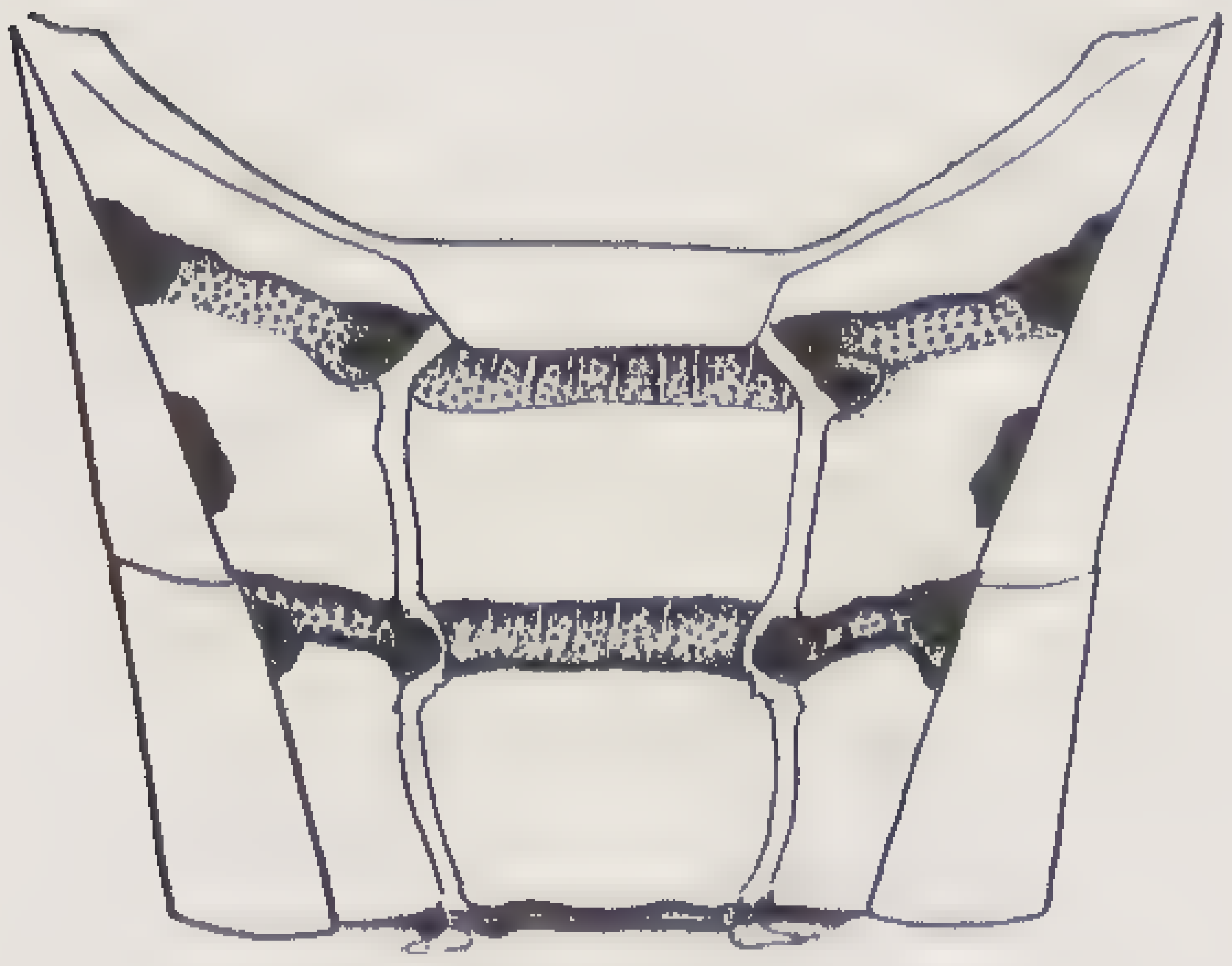
46a R.(R.) gracilis



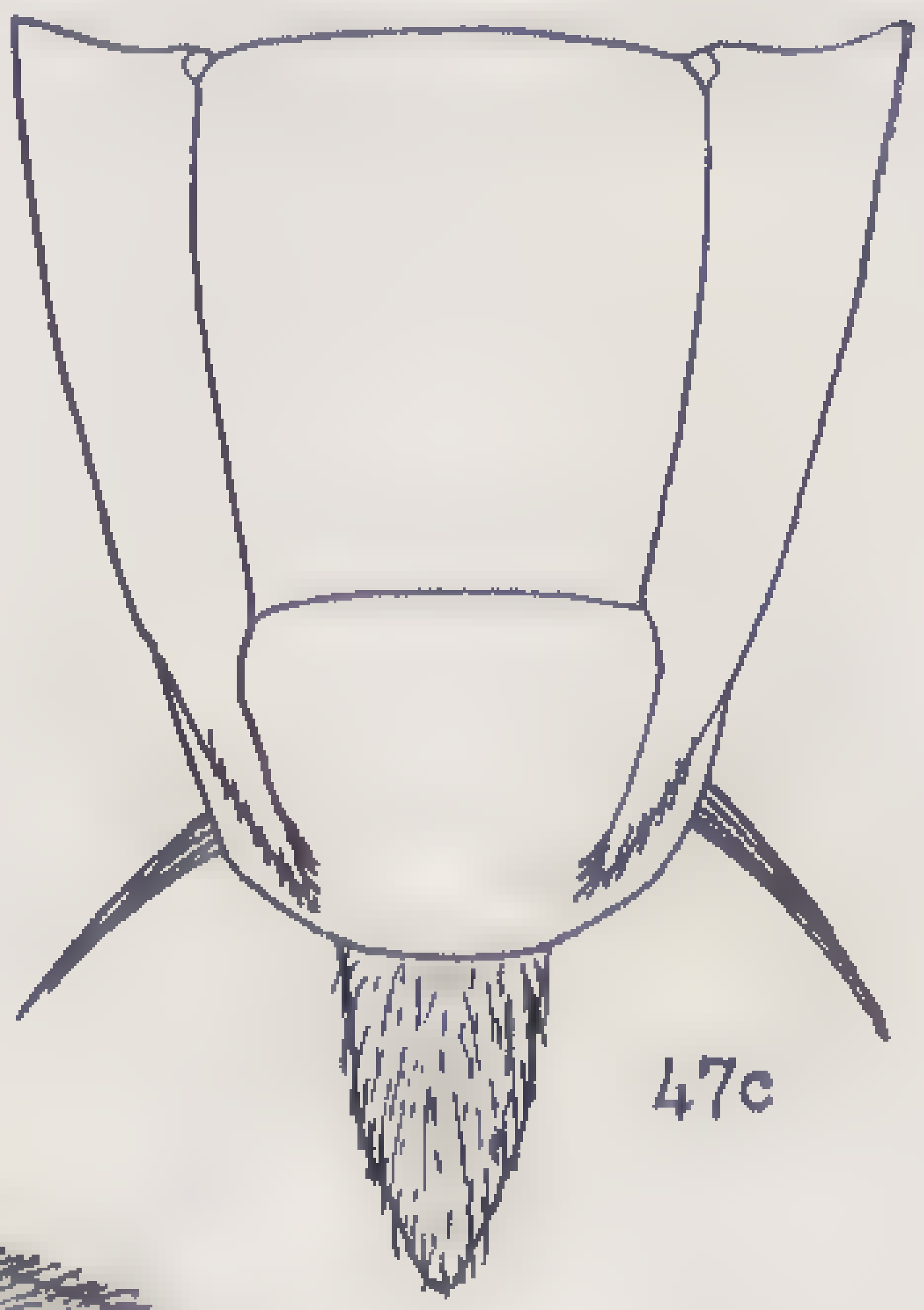
46c



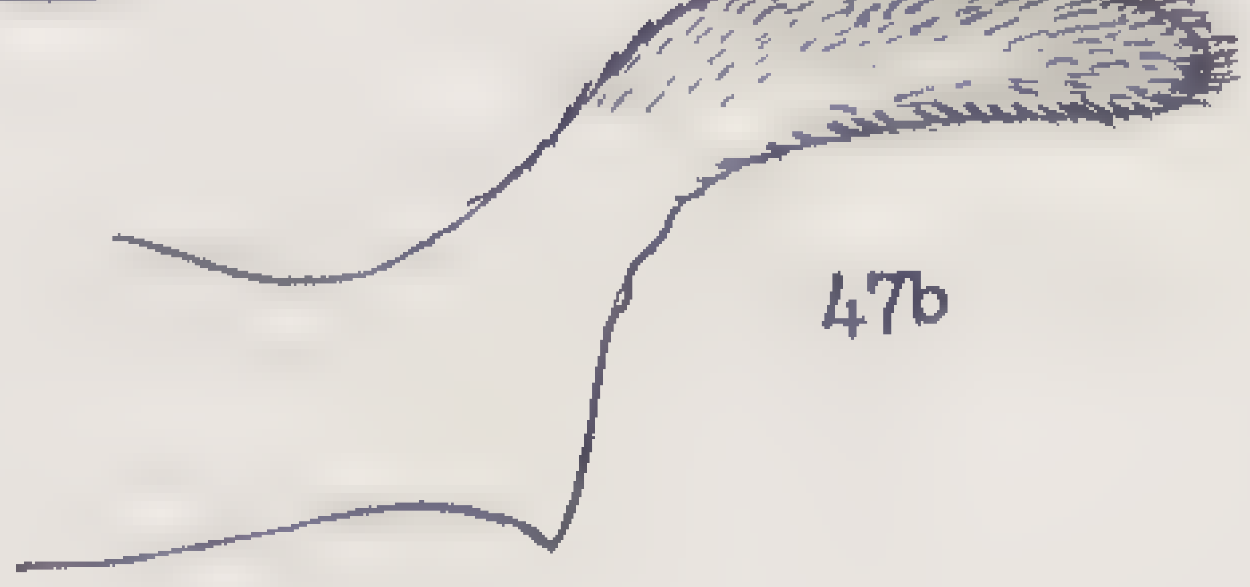
46b



47a R.(R.) becki



47c



47b

PLATE 15

DORSAL VIEW OF ABDOMINAL SEGMENTS AND LATERAL VIEW OF PRONOTUM

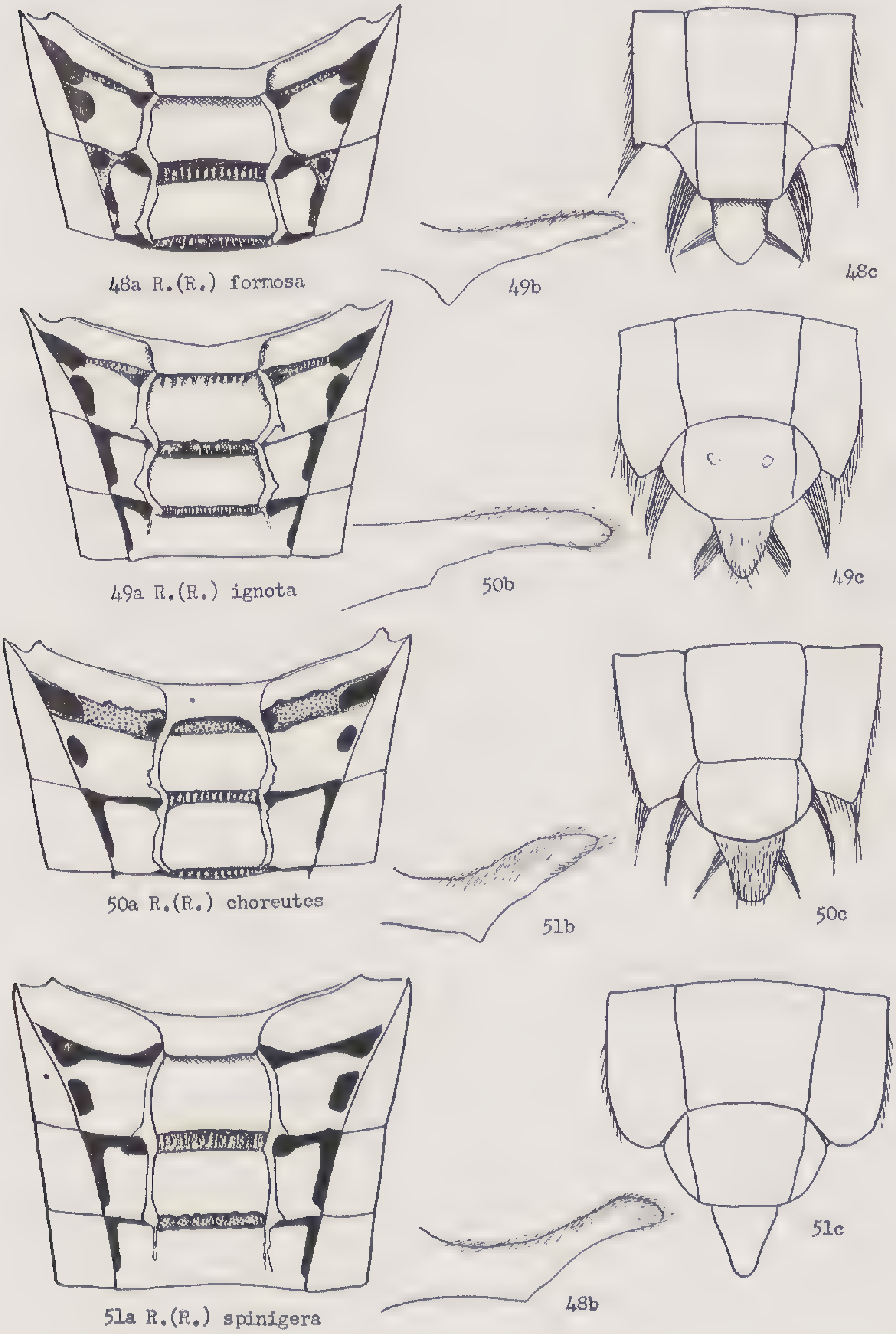
FIG. 48a. Basal abdominal segments of *Rhagovelia* (*Rhagovelia*) *formosa* Bacon; 48b, apical portion of pronotum; 48c, apical abdominal segments of winged female.

FIG. 49a. Basal abdominal segments of *Rhagovelia* (*Rhagovelia*) *ignota* Drake and Harris; 49b, apical portion of pronotum; 49c, apical abdominal segments of winged female.

FIG. 50a. Basal abdominal segments of *Rhagovelia* (*Rhagovelia*) *choreutes* Hussey; 50b, apical portion of pronotum; 50c, apical abdominal segments of winged female.

FIG. 51a. Basal abdominal segments of *Rhagovelia* (*Rhagovelia*) *spinigera* Champion; apical portion of pronotum; 51c, apical abdominal segments of winged female.

PLATE 15


48a R.(R.) formosa
49a R.(R.) ignota
50a R.(R.) choreutes
51a R.(R.) spinigera

THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN

VOL. XXXVIII, PT. I]   DECEMBER 20, 1956   [No. 12

Concerning the Relationship of Certain Neotropical Gekkonid Lizard Genera, with Comments on the Microscopical Structure of Their Glandular Scales

BY

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ABSTRACT: The classification of the gekkonid lizards is reviewed briefly. The recent family classification of the gekkonid lizards by Garth Underwood is discussed and followed as far as Western Hemisphere groups are concerned. The absence of femoral pores in all endemic species of the Gekkonidae in the Western Hemisphere is reported. The genera *Peropus* and *Hemidactylus* are regarded as transported here by man. Specialized glandular scales on the posterior ventral and subfemoral regions are discussed and a preliminary microscopical study of the scales is offered. The name "escutcheon scales," proposed for these by Chapman Grant, is used. It is believed that these scutes may represent the ancestral type of the femoral and preanal pores.

For a considerable time the gekkonid lizards have been of much interest to the senior author who in his field exploration in various parts of the world has collected representatives of some eighty forms of these interesting saurians, several of which have been described as new. His recent review of the lizard fauna of Costa Rica has again opened the problem of the classification of the gekkonid lizards and he found it necessary to make a cursory review of those groups occurring in the Western Hemisphere, and to make an attempt to re-evaluate the rank of the groups represented.

In the latter half of the 19th century the gekkonid lizards were regarded as belonging to three families: the Uroplatidae, Eublepharidae and the Gekkonidae. This arrangement was used by Boulenger in his British Museum Catalogue and by Cope in his work on American Herpetology. It was likewise followed by a majority of the herpetologists of their time.

Fürbringer (1900) published a classification of the lizards recognizing three families. However he placed the Uroplatidae in a "*gens*" different from the other two. The following year Gadow (1901) considered all the gekkonid lizards under the suborder Geckones placing them in a single family, Geckonidae, with three subfamilies—Uroplatinae, Eublepharinae, and Geckoninae. After a time there was a tendency on the part of herpetologists to follow this arrangement, but not without some variation. Thus Charles Camp (1923) in his scholarly contribution on classification, reviewed the Sauria, recognizing the Uroplatidae as a distinct family but treating the Eublepharidae with the Gekkonidae.

One of the troublesome groups formerly associated with the Gekkonidae is one comprising certain small Central and South American saurians including the genera *Sphaerodactylus, Gonatodes, Pseudogonatodes, Coleodactylus* and *Lepidoblepharis.* Moreover, one cause for this trouble was that certain forms in South Asia (of different relationship) were placed in the genus *Gonatodes* erroneously, so that one had in a single genus both amphicoelous and procoelous forms, thus rendering the character of the vertebrae useless for the separation of families.

G. K. Noble (1921) in his study of *Sphaerodactylus* and allied genera noted the characteristics of the group in Central and South America. He found it necessary to remove this group of genera from the Gekkonidae proper and associate it with the Eublepharidae. Moreover, he did not include amphicoelous Asiatic forms in *Gonatodes.* Werner (1912) already had referred *Lepidoblepharis* to the Eublepharidae. Noble was convinced that these genera of small saurians represented a natural group. Concerning the vertebrae he states, "The procoelous vertebrae have been developed in this series quite independently of similar changes in any other series." Despite numerous other differences he associated them with the Eublepharidae chiefly on the basis of this one character.

H. W. Parker (1926) treated this same group, adding to it another genus, *Coleodactylus.* He subscribed to the Gadow classification and all were placed in the Gekkonidae. The Zoological Record of 1926 did not use the family name Eublepharidae and it did not appear in the American Checklist of Stejneger and Barbour of 1923.

Smith and Taylor in their Mexican checklist (1946) reluctantly followed this usage although it was apparent to both authors that the arguments were equally as strong for the retention as for the abandonment of the family. Since they were not treating species of the Uroplatidae the status of that family was not their immediate concern. As for the group delineated by Noble, his opinion as to their relationship was accepted. The group entered Mexican territory only in the southern part and two diminutive species of *Sphaerodactylus* were the only ones available to them in their collections.

To the senior author in his studies of the Costa Rican fauna, the group was more important since Costa Rica has representatives of three genera and several species and the general characteristics of the group were examined. It was noted that, aside from the procoelous vertebrae, the paired parietals, sternum characters, and the sternum-rib relationship pointed out by Noble, they lacked a voice mechanism. The "clutch" consisted of a single egg at one laying. Neither postanal sacs nor postanal bones were present in either sex. It was noted that the males and females had no femoral or preanal pores but that there were present in males a series of specialized glandular scales in the posterior region of the venter. In some species these also appeared in the femoral region, suggesting their possible analogy to the true femoral and preanal pores.

He began a hasty search of the literature to ascertain whether these characters had been described and was informed by his student, Mr. Peter Chrapliwy, of the description by Maj. Chapman Grant (1931) in a paper dealing with West Indian members of the genus *Sphaerodactylus,* and of the work by Noble and Klingel. Grant who seemingly was the first to mention them in literature had given the name of "escutcheon scales" to this group of glandular scales. Noble and Klingel seem to have been the first and perhaps the only subsequent workers to give consideration to these scales. Aside from noting the escutcheon scales on certain species they made a preliminary study of the microscopical structure (Noble and Klingel, 1932).

From the first we were convinced that the group unquestionably merited at least subfamily recognition and proposed to deal with it in this category. Shortly after, we received a paper by Garth Underwood (Nov., 1954) * dealing on an extensive scale with the anatomy and classification of the Gekkoes.

While it is somewhat futile to report our own proposals for the arrangement of the American gekkonid lizards, they were as follows:

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* This paper was first received by us in May, 1955. A report on our study was presented by the senior author at the 1955 meeting of the American Society of Ichthyologists and Herpetologists at San Francisco in June.

ARRANGEMENT OF AMERICAN GEKKONIDS

- Eublepharidae
  - Eublepharinae (with preanal pores)
    - Coleonyx
  - Sphaerodactylinae (with specialized glandular scales in males uncertain in Pseudogonatodes and Coleodactylus)
    - Gonatodes Fitzinger
    - Sphaerodactylus Wagler
    - Lepidoblepharis Peracca
    - Pseudogonatodes Ruthven
    - Coleodactylus Parker
- Gekkonidae (without preanal or femoral pores)
    - Bogertia Loveridge
    - Briba Amaral
    - Thecadactylus Cuvier
    - Aristelligella Noble
    - Tarentola Gray
    - Homonota Gray
    - Phyllopezus Peters
    - Aristelliger Cope
    - Discodactylus Titschack
    - Gymnodactylus Spix
    - Phyllodactylus Gray
    - (nonendemic imported forms) femoral and/or preanal pores present
    - Hemidactylus Cuvier
    - Peropus Wiegmann

Underwood has arrived at his classification largely through a study of the eyelids and the structure of the eye itself, characters that we had not considered in our own work. He has not used this, however, to the exclusion of other important characters. One significant fact which we overlooked was that sexual dimorphism in color was a presumed universal characteristic of the group. We were, of course, aware that it occurred in certain species.

Underwood recognizes the superfamily Gekkonoidea and under it his arrangement of families is as follows:

- Gekkonoidea
  - Eublepharidae
  - Sphaerodactylidae
  - Gekkonidae
    - Gekkoninae (including Uroplatidae auct.)
    - Diplodactylinae

We are accepting Underwood's general arrangement of families for the Western Hemisphere. There remains considerable doubt as to the wisdom of placing the Uroplatidae in the subfamily Gekkoninae since in so doing numerous significant characters seemingly are disregarded.

Since Underwood restricted the genus *Gymnodactylus* to South America, of the endemic genera of American gekkoes only *Phyllodactylus* has representatives outside of the Western Hemisphere with femoral or preanal pores. Tarentola also with Old World representatives may have some special glandular scales such as occur in *Sphaerodactylidae.*

The specific function of preanal or femoral pores has not been satisfactorily explained. The pores when present are usually in males; however, in some groups they may appear in females or they may be absent in both sexes. Thus the pores are present in the males of the Eublepharidae but are absent in all endemic genera and species of the Gekkonidae in the Western Hemisphere. Thus it would appear that there is nothing that acts as general inhibitor for the development of pores save in the case of the Gekkonidae. Nor would it appear that the absence of pores has had any marked effect on the success of the forms.

Species of *Hemidactylus* and *Peropus* have lines of femoral or femoro-preanal pores but we suspect that these species have all been imported or if they have developed into new subspecific forms, this has happened since their importation by man.* Seemingly these forms thrive here with the pores present and the question of their importance in survival is unanswered. Certain species of *Hemidactylus* have been described in the Western Hemisphere that were presumed to be of endemic origin.

In the Sphaerodactylidae the males of the Central American forms all have a group of glandular scales (escutcheon scales) in the posterior region of the venter and many have this series continued along the underside of the femur sometimes to near the knee; and in at least one genus (*Gonatodes*) some of the postanal scales may be so modified. These scales are not distinctly modified in the females.

Where series have been available the number of these scales has varied somewhat, and in the case of *Lepidoblepharis xanthostigma* the variation is considerable. It was noted that the smaller numbers were counted in young males, the largest numbers in old males. As an example, the senior author reports on a series of specimens from Limón, Costa Rica, in which 28 to 46 could be counted in a juvenile and young adults, while 60 to 110 occurred in larger and older specimens. It seemed probable that while the entire lot of scales is early differentiated all do not take on their adult characteristics until much later. Even in some of the largest, presumably oldest specimens some of the scales adjoining the escutcheon scales often exhibited areas lacking surface pigment. The femoral scales in this species may be in a single row with three or four scales or there may be two rows with five or six altogether. These are always widely separated from the ventral escutcheon.

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* One might conceive of a pair of eggs of the highly domestic *Hemidactylus* carried to this country from the Philippines. The resulting animals might, in a relatively short time, with brother-sister matings, produce a population showing differences from the original Asiatic population due to the stoppage of gene flow from an Asiatic source.

In the genus *Sphaerodactylus* this differentiation between young and old is less obvious and the femoral series, if present, are contiguous with the escutcheon scales on the venter. This genus has two groups in Costa Rica one of which has the escutcheon on the posterior ventral region but lacks entirely the femoral glandular scales; the other group has them present. The number and arrangement varies from species to species. We did not find any evidence of postanal glandular scales in the genus.

Gonatodes fuscus differs from the other two genera in having a larger number of the scales in the escutcheon. The area extends forward nearly one third of the length of the body, and consists of approximately 200 scales, with about 50 similar scales on the under surface of each femur.

It seems probable that the character of these scales will serve to assist in distinguishing species—perhaps subgenera and genera—in the family Sphaerodactylidae, and should be described in detail for each form.

While we have at hand no specimens of *Pseudogonatodes* or *Coleodactylus,* we have made a superficial examination of specimens of *Pseudogonatodes* at the Agassiz Museum at Harvard College.* We did not find the scales present in what we identified as males on the basis of external characters. We have seen no specimens of *Coleodactylus.* Should the escutcheon be absent in one or both of these genera it should not lessen the importance of the character as helping define the family. However, the poreless genera of the Gekkonidae should be carefully examined for species with scales of the escutcheon type.

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* Our thanks are due to Mr. Arthur Loveridge for the privilege of examining this material.

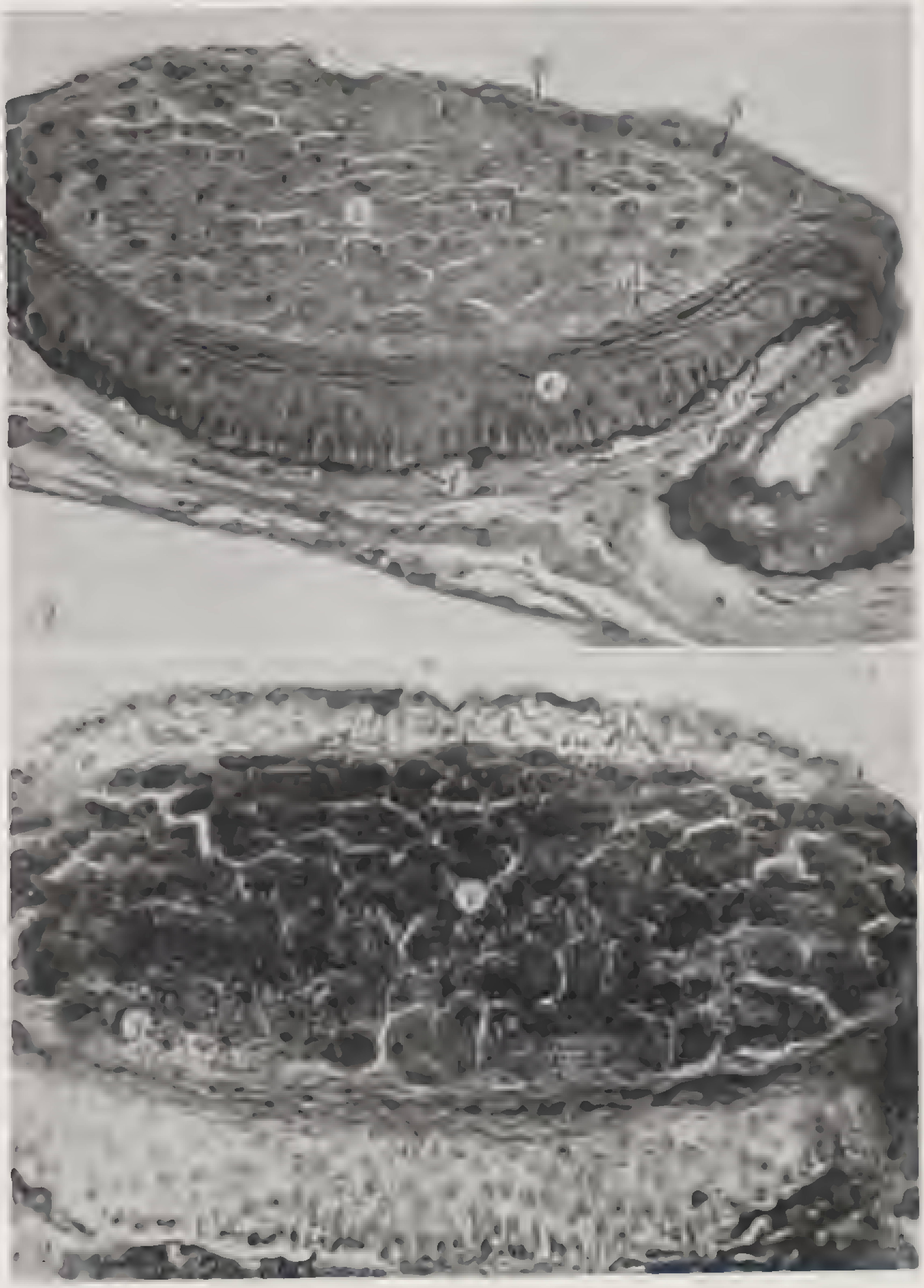
STRUCTURE AND MICROSCOPIC ANATOMY OF THE ESCUTCHEON SCALES

In preserved material the unpigmented surface epithelium of these escutcheon scales can be removed by gentle pressure and a rubbing movement of the thumb or finger. The normal scales, or the scales in the same area in females, remain completely intact by the same treatment. When the surface is removed the granular mass is exposed and may be partially or completely removed with a dissecting needle, thus leaving a cuplike depression lined by basal pigmented epithelium. Ordinarily the escutcheon cells are creamy white or white in color with a somewhat darker edge. This is due to the fact that the rim of the "cup" is pigmented and is visible through the transparent scale cover.

As pointed out the number of the visible glandular scales may be reduced in the young, but scales contiguous to these, as the animal grows older, take on the general characteristics of the glandular scales; scales touching these in turn seemingly become changed to the glandular type. How long this process is continued we do not know. In some old specimens of *Lepidoblepharis* with the highest numbers, adjoining scales may show a portion of their surface lacking pigment.

The histological specialization of the scales on the preanal, femoral, and sometimes the postanal regions of males of the Sphaerodactylidae is unique in our experience, and unlike any dermal specialization in lizards, or other animals, known to us.

The base of the scales in question is depressed to produce a definite pit, the floor of which is formed by a typical cornified stratified squamous epithelium and carries the typical pigmentation of *external* layers (fig. 1, *c*, *g*); this layer is continuous from scale to scale among the specialized ones, and continues onto the unspecialized scales, where it forms the superficial layer. This *basal epithelium* is typical of such epithelia as they occur in higher vertebrates generally; the germinative layer (fig. 1, *g*; fig. 2, *b*) rests on a basement membrane of collagenous connective tissue (fig. 1, *f*) within and below which are dense aggregations of pigment cells (fig. 1, *f*). Above the germinative layer, which consists of columnar cells for the most part, there is a layer of more or less rounded or polygonal cells ranging from three to eight cells in thickness. Near the surface of the basal epithelium the cells become flattened and cornified (fig. 1, *e*; fig. 2, *k*); it is these cells which on unspecialized scales form the outer protective desquamating covering.



Microscopic Anatomy of Specialized Scales from the Preanal Region of *Gonotodes fuscus* (Hallowell)

FIG. 1. *a*, cornified capping epithelium; *b*, germinative layer of capping epithelium; *c*, granular, "secretory" cells; *d*, germinative layer of "secretory" cells; *e*, cornified layers of basal epithelium; *f*, pigment cells below germinative layer of basal epithelium; *g*, continuity of basal epithelium from scale to scale. Celestine Blue and eosin; magnification, × 220.

FIG. 2. *h*, germinative layer of capping epithelium; *i*, granular cells of "secretory" epithelium; *j*, germinative cells of "secretory" epithelium; *k*, cornified layer of basal epithelium. Mallory's Triple Stain; magnification, × 250.

Within the depressed portions of the specialized scales, however, another germinative epithelium (fig. 1, *d*; fig. 2, *j*) composed of large faintly staining cuboidal to rounded cells lies in direct contact with the cornified cells of the basal epithelium. This second germinative epithelium produces large, polygonal to depressed rhomboidal cells containing dense accumulations of coarse granules (fig. 1, *c*; fig. 2, *i*) which are presumed to be secretory in nature. For this reason this layer is here referred to as the *"secretory" epithelium.* The cells of this layer fill the cuplike depression of the scale, and often produce a distinct convexity on the outermost surface. The granules of these cells stain faintly with Celestine Blue, but with Mallory's Triple Stain they become deeply pigmented (fig. 2, *i*). There is but little modification among these granular cells, except a slight degree of depression near the outer surface of the layer.

A third germinative epithelium rests on the granular cells of the secretory epithelium (fig. 1, *b*; fig. 2, *h*); these cells are cuboidal to rounded, and seem never to be columnar. They give rise to a layer not more than three to five cells in thickness which quickly becomes cornified and squamose; we refer to this outermost nonpigmented epithelium as the *capping epithelium.* This varies in thickness, but everywhere presents the same general characteristics and in preserved specimens as stated may be removed by rubbing a finger over the surface.

The arrangement of three distinctive superimposed epithelia in these scales not only provides a unique morphological feature that serves to distinguish these lizards from others known to us, but raises several intriguing biological problems. For example, how these superimposed epithelia are nourished, situated as they are above one or more layers of cornified cells of presumed impermeability, and certainly remote from the circulatory supply that lies below the basal epithelium, presents a difficult problem. Furthermore, the function of the secretory epithelium is unknown to us. It seems obvious that these cells pass through a cycle of biochemical stages, typical of secretory cells (compare fig. 1, *c* with fig. 2, *i*) since in our material it can be observed that the granules become larger as the cells enlarge; in addition, the staining properties of the cells when treated with Mallory's stain is not consistent; some cells stain deeply with fuchsin, others with aniline blue, and certain cells contain granules some of which take the blue stain, others the red. Still another problem is raised by the observation that the germinative layer of the secretory epithelium and that of the capping epithelium are frequently out of phase; that is, when one seems active and well developed, the other seems less so (compare fig. 1 with fig. 2 with reference to the germinative layers). In some scales the capping layer seems to have desquamated to the point of nearly exposing the underlying secretory cells (fig. 1) but whether or not the secretory cells actually become exposed at the surface is not revealed by any of our material. Unfortunately for present purposes, all the material available to us was collected by the senior author in a single season (summer) of the year, so that presumed cyclic changes in the specialized scales cannot be determined at this time.

The relationship of these scales to the preanal and femoral pores is uncertain.* Their position on the body in the same general areas as the pores suggests that they may subserve the same general purpose. One might suspect that they represent a primitive stage in pore development. The femoral and preanal pores themselves are of several kinds and may be polyphyletic in origin. Further study is necessary to ascertain the degree of relationship.

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* The preanal pores on the gekkoes of the genera *Naultinus*, *Hoplodactylus*, *Rachodactylus*, and perhaps others are arranged in patches or in several rows. The number is excessive and may reach 80 or more in one or more species. At the moment none of these lizards are available to us for examination. It is possible that these may throw some light on the relationship of the escutcheon scales to true femoral and preanal pores.

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